Dublin Institute for Advanced Studies

STRATEGIC PLAN 2012 – 2016

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CHAIRPERSON'S FOREWORD

The Chairman of Council, Dr. Vincent Cunnane at an event in celebration of the 70th Anniversary of the foundation of DIAS.

DIAS is an internationally renowned research institute established over seventy years ago by the government of the Taoiseach Éamon de Valera (Institute for Advanced Studies Act, 1940). Modelled on the Princeton Institute for Advanced Study (1930) it combines humanistic and scientific disciplines in a framework of three independent schools, Theoretical Physics, Celtic Studies and Cosmic Physics. Its foundation during World War II was hailed as a demonstration that "there is a better way than war for advancing the welfare of mankind". Its existence remains a powerful and continuing symbol of the value attached by Ireland to research and scholarship, a symbolism reinforced by the historical associations with the sanctuary offered to the Nobel Prize winner Erwin Schrödinger who became the first Director of the School of Theoretical Physics. By maintaining the great distinction of its constituent schools, DIAS has and continues to realise the ambition set for it at the time of its foundation, which was "that all the various rays of credit, the good name that we get, may be focussed into a single institute". (An Taoiseach, Seanad Éireann 24 - 15 May, 1940, http://historical-debates.oireachtas.ie/S/0024/S.0024.194005150003.html p.6)

Today, DIAS is Ireland's pre-eminent 4th/5th level academic establishment with wide international ties in Europe and throughout the world. Its mission is threefold: (1) to further advanced study and the conduct of research by senior scholars in each of the specialised branches of knowledge practised in its constituent schools; (2) to provide facilities to which researchers of international repute, including postdoctoral fellowship-holders in these disciplines, are attracted; (3) to engage in the mentoring and training of gifted doctoral scholars in the methods of fundamental research and scholarship. In the science field DIAS has succeeded at all times in attracting the expertise of outstanding scientific researchers from abroad to work in Ireland, and has thereby made a major contribution to Ireland's intellectual life and international prestige. In Celtic Studies its stature as the paramount world-centre of the discipline is shown by the fact that virtually all scholars of international repute currently active in Europe and further afield have links to the School or have received some of their training in DIAS.

DIAS enjoys the status of an independent facility with cooperative links to universities and institutes, both nationally and internationally and offers a valued neutral space for a wide range of original and innovative blue-skies research projects and initiatives. This has enabled each of its Schools to take the initiative in establishing important shared national research infrastructures. Among such recent initiatives have been the establishment

of the Irish Centre for High-End Computing (School of Cosmic Physics); the Irish-Script-on-Screen ISOS Project (School of Celtic Studies) and the development of the advanced optical network and national data store in the e-INIS project (School of Cosmic Physics). Original DIAS research projects on the science side have brought unexpected results with profound long-term economic significance. A striking example has been its fundamental work, initiated in the 1980's, on the formation of the North Atlantic Ocean which showed that the Irish continental shelf is twice as large as previously thought, comprising up to ten times the land mass; this represents a huge expansion of the area over which Ireland has substantial rights under the Law of the Sea. Another instance of unexpected economic advantage, based on research by DIAS, relates to the study of the foundations of statistical mechanics and the relation of entropy to information; this led to the realisation that similar ideas could be applied to telecommunications and a successful high-tech start-up company was established to exploit resulting intellectual property. The School of Celtic Studies remains the paramount centre of long-term research in Irish and Celtic studies and continues to be the world-leading publisher of academic material in the discipline. Its publishing and reprinting programme is funded entirely from the profits of its book-sales.

The DIAS template, like that of Princeton IAS, is of a self-standing research institution with light administrative overheads; it is part of the academic system yet offers a neutral space to scientists and scholars from a mixture of disciplines who come together in the common pursuit of knowledge. In the European context in the post-war period an ever-increasing number of similar research institutes have been established in advanced countries (Germany, the Netherlands, UK, Sweden and Finland). Accordingly, far from being superseded or superfluous, the influence of the DIAS model is more and more evident in societies that are to the forefront in fostering the knowledge economy. DIAS has continuously driven inter-institutional collaboration and advances the establishment of common infrastructures. It produces discoveries of real economic benefit. It contributes added value to the graduate training experience of the universities. Not least, as envisaged at its foundation "in an extraordinary time", it continues to have significant symbolic value for the nation, bringing to it major credit internationally.

Since my appointment as Chairman of Council I have been greatly impressed by the quality and enthusiasm of the staff at all levels in the Institute. The response of DIAS to current challenges has been pragmatic and innovative. DIAS is both a national resource and a national treasure. Ireland and the international community need DIAS to continue to challenge the levels of our knowledge and to communicate this to an ever changing world. This Strategic Plan addresses all the key issues to sustain and grow this unique institution.

Dr Vincent Cunnane
Chairperson of the Council

EXECUTIVE SUMMARY

The Dublin Institute for Advanced Studies (DIAS) will remain a force for excellence in fundamental research, contributing to the public good and with global impact. Since its foundation in 1940, it has created a community of independent, critical and creative thinkers based in and around DIAS, with extensive networks of national and international collaborators, which generates research of the highest international standard; mentors and provides opportunities for outstanding young researchers; and enhances the scientific, cultural and economic life of Ireland.

DIAS is an independent statutory corporation reporting directly to the Oireachtas through the Department of Education and Skills. It is unique among Irish academic institutions in having an exclusive focus on research excellence and in having no undergraduate teaching mission. Its research work is currently organised in three Schools, each overseen by an independent international Governing Board of the highest distinction. The Schools come together under an overarching Council which provides a common legal identity and oversees the buildings, assets, central administration and shared services of DIAS. This structure, adopted from the Princeton Institute for Advanced Study, allows the Schools the freedom to pursue their diverse research interests within a well-defined cohesive and efficient management structure, optimised to support the unique research-focussed mission of DIAS.

The School of Celtic Studies (SCS) is the world-leading research centre for the Celtic languages and literatures and is the principal academic publisher in its field. Its work is fundamental to understanding Irish history, culture and national identity. Through its pioneering projects in the digital humanities its contributions are now globally accessible on the internet.

The School of Theoretical Physics (STP) investigates the fundamental mathematical structures in which the laws of physics find expression, carrying on the proud Irish tradition of Hamilton, McCullagh and Boole. This research has profound, if long-term, implications not just for our understanding of the structure and origin of the universe, but, through quantum information theory, for the future of computing and the limits of what is computable.

The School of Cosmic Physics (SCP) takes physics out of the laboratory and uses it to explore and explain the universe and world around us, literally from the centre of the Earth to the edges of the observable universe. It has radically changed our views of Ireland's continental shelf, with significant economic impact; has led Ireland into space research and new areas of Astronomy; and has been a major force in the development of shared national research infrastructures such as the Irish Centre for High-End Computing, the Irish National Seismic Network and the National Data Centre for the CTBTO. It has just established a Centre for Astroparticle Physics and Astrophysics and is involved in the search for sources of geothermal energy in Ireland.

In this Strategic Plan each of the three Schools has proposed an exciting programme of fundamental research for the next five years. In the natural sciences, DIAS will work on, among other topics, understanding star formation, the nature of cratons, the origin of cosmic rays, the nature of dark matter and its possible connection to supersymmetry, the potential of quantum information theory and computing. In Celtic Studies projects for completion and publication in the period of the Plan will include several for the Early Irish Law Series and in addition, a number of critical editions of medieval literary works and bardic poetry; two major Irish manuscript catalogues will also be completed as well as two monographs on Irish dialects. The School will also vigorously pursue the high

objectives of the various components of the School's Digital Manuscripts Initiative.

The Schools are committed to enhancing the contribution DIAS makes to mentoring and training early stage researchers. They will provide opportunities for debutant Irish and international researchers to participate in research projects at the highest level, facilitate meetings with visiting scholars, organise workshops, conferences and summer schools, and coordinate advanced modules for our partner third-level institutions as part of their structured PhD programmes.

DIAS will develop its public outreach activities based around the statutory public lectures organised annually by each School, the series of Open Nights and other public events at Dunsink Observatory, the Seismology in Schools initiative, and the annual Tionól of the School of Celtic Studies.

The work of each School will continue to be overseen by its Governing Board (see Appendix 8) and will be critically reviewed by an international visiting panel every five years. The panels spend several days talking in confidence to staff at all levels and examining the research performance of the School over the previous five years. At the end of the review they report directly to the Council of DIAS (see Appendix 8) and to the Chairman of each Governing Board. This exceptional (for Ireland) level of external scrutiny by international peers has proven a very valuable instrument in ensuring that DIAS remains true to its research-focussed mission and will be continued.

DIAS recognises that the next few years will be an exceptionally challenging time and that flexible, pragmatic and innovative approaches will be required to enable DIAS to continue to discharge its unique and valuable mission. It will continue to focus on fundamental research questions

Chairman of School of Cosmic Physics Governing Board, Prof. Gerry Wrixon, Chairman of Council, Dr. Vincent Cunnane, Prof. Dervilla Donnelly, Prof. Robbert Dijkgraaf, Director of the Institute for Advanced Studies Princeton, Chairman of School of Theoretical Physics Governing Board, Prof. Arthur Jaffe, Chairman of School of Celtic Studies Board, Prof. Anders Ahlqvist.

but will develop new models for collaborative research partnerships to enable it to do this more efficiently. It will seek to co-locate all the research work and the administration on a single physical site to benefit from shared resources and increased cooperation between the Schools. It will seek to diversify its sources of research funding and establish a charitable foundation to seek philanthropic support.

The value to Ireland of DIAS's unique mission has been demonstrated over the last seventy years. It has greatly enhanced DIAS's profile and reputation internationally, augmented the pool of human capital and skills in the country and delivered serendipitous discoveries with economic impact. DIAS looks forward to playing its part in the national recovery through this Strategic Plan and it will work closely with the Department of Education and Skills, and other stakeholders and state agencies, to contribute fully to the formulation and implementation of the National Research Agenda.

VISION, MISSION AND VALUES

Vision

DIAS will be a force for excellence in fundamental research to the benefit of all.

Mission Statement

The mission of DIAS is to foster a community committed to independent critical enquiry that enables researchers to achieve their fullest potential. It will create, preserve and communicate knowledge; mentor and develop young researchers in an environment of excellence; and enhance scientific, cultural and economic life locally, nationally and internationally.

DIAS will:

- continue to develop and expand as a recognised world-class centre for fundamental research in its specialist areas of expertise
- seek to establish new Schools in emerging areas that represent academic and societal opportunities
- recruit leading researchers in its specialist fields
- maintain the highest standards of research and scholarship
- help to shape the direction of research in Ireland
- enhance the international reputation of Irish research
- provide appropriate support for national research strategies
- engage in suitable research collaborations with other Irish institutions

Values

At DIAS we value:

- academic excellence
- freedom in the pursuit of research
- cross-disciplinary dialogue
- engagement in public discourse
- international recognition
- teamwork and collegiality
- national and international collaborations
- administrative and institutional autonomy

"Within their disciplinary areas the academic staff of DIAS operate as scientific and cultural ambassadors for Ireland on the world stage, establishing links, enabling networks and promoting Ireland's reputation".

FUNCTIONS OF SCHOOLS

The Dublin Institute for Advanced Studies was established by the Institute for Advanced Studies Act, 1940 and is currently comprised of the School of Celtic Studies, the School of Theoretical Physics and the School of Cosmic Physics. DIAS reports directly to the Oireachtas through the Department of Education and Skills.

DIAS is unique among Irish academic institutions by virtue of its exclusive focus on excellence in fundamental research and its freedom from responsibility for undergraduate training. An efficient governance and management system has been evolved which is tailored exclusively to supporting the research endeavour.

While the three DIAS Schools operate in different areas of human thought and experience they have the common purpose of extending the boundaries of knowledge, fostering critical analysis and developing new cross-disciplinary syntheses.

School of Celtic Studies

The principal function of the School of Celtic Studies (SCS) is the furtherance of the study of the Celtic languages and literatures through a wide-ranging programme of investigation, editing and publication, and through training and mentoring students in advanced methods of original research. In particular, the School is charged with the investigation and editing of literary, historical, legal and technical manuscript materials in the Irish language; the study and elucidation of Old, Middle and Modern Irish grammar, lexicography and philology; and the recording and linguistic analysis of the living speech of Irish dialects. Its role includes the organisation of seminars, conferences and lectures of interest to students of the Celtic languages and the commissioning and editing for publication of works dealing with the Celtic Studies and Hiberno-Latin.

School of Theoretical Physics

Foremost among the functions and duties assigned to the School of Theoretical Physics (STP) is the investigation of the mathematical principles of the laws of nature and the training of students in methods of original research. These two activities have been inextricably intertwined since the foundation of the School. The School's research programme seeks to establish links with other international research institutions, and universities within Ireland. It sees the establishment of the School and Ireland as centres of learning that attracts exceptional staff and high-calibre students of the postdoctoral type from abroad as part of its function. Of no less importance is the duty of the School to provide facilities for advanced study and research in theoretical physics for those on leave of absence from their academic duties and to organise seminars, conferences and lectures on topics related to theoretical physics which lie on the frontiers of knowledge.

School of Cosmic Physics

The mandate of the School of Cosmic Physics (SCP) is to undertake theoretical, computational and observational studies of physics related to the understanding of the Cosmos, from the Earth's core to the outer reaches of the Universe and, by the training and mentoring of students and postgraduates, to contribute to the pool of human capital and specialist skills in Ireland. This includes, but is not limited to, astronomy and astrophysics, astroparticle physics, solid Earth geophysics, fluid geophysics, meteorology and oceanography and the interaction between the solid, liquid and gaseous Earths (land, sea, air). The School is currently functionally structured into two divisions, one focussed on the interior and surface of the Earth (the Geophysics section) and the other focussed outwards (the Astronomy and Astrophysics section). The School leads national activity in these areas and is well-respected internationally for the depth, breadth and quality of its activities.

CURRENT WORK AND FUTURE PERSPECTIVES

School of Celtic Studies

The School of Celtic Studies (SCS) is the acknowledged world-centre for research in Celtic Studies and the foremost publisher of discipline-related scholarly books and online materials in the field. Its wide-ranging research and publishing programmes cover every aspect of Irish philology and also encompass the language and literature of Welsh, Scottish Gaelic, Breton and Hiberno-Latin. SCS's senior researchers are preeminent in their respective fields of expertise, and collectively through continuity of effort on individual and joint projects the School makes a strong and prominent contribution to awareness of national identity, history and Irish cultural individuality. This will continue in the period of the present Strategic Plan.

Important research projects for completion and publication in the shorter term by members of SCS include several for the Early Irish Law Series (editions of *Córus Bésgnai* and *A Legal Treatise by Giolla na Naomh Mac Aodhagáin*); critical editions of medieval literary works and Bardic Poetry collections (*The Triads of Ireland*; *Poems of Fearghal Óg Mac an Bhaird* and *Chronicle Poems of the Nine Years' War*); Irish manuscript catalogues and palaeographical studies (*Catalogue of the Irish manuscripts in the library of Trinity College Dublin. Fasc. I: Medical manuscripts; The catalogue of Irish manuscripts in the Belgian Royal Library, Brussels; The Four Masters and their manuscripts*); grammatical studies (*A Grammar of Middle Irish*); and Irish dialect monographs (*The Irish of Rann na Feirste and Gaeilge Achréidh na Gaillimhe*).

SCS is in the forefront of innovative research using digital technologies in the related fields of Irish manuscript and textual studies and script history. Its Digital Manuscript Initiative currently coordinates three important joint in-house projects. (1) 'Irish Script on Screen' (ISOS) was established to provide high-resolution images of entire manuscripts in the Irish language cover to cover. The ultimate aim is to provide a virtual library of manuscripts from the 7th to the 19th century with the cooperation of libraries in Ireland and abroad. Images are freely available on a dedicated website: www.isos.dias.ie. The project is a world leader in manuscript imaging and display and provides world-wide access to Irish manuscripts from all the principal Irish manuscript libraries (RIA, NLI, TCD, UCC) and important foreign collections (National Library of Scotland) with accompanying digitised descriptive commentaries. Recent highly significant additions to the ISOS portfolio from private hands have included the single largest collection of Irish bardic poetry now extant known as the Book of The O'Conor Don. (2) The 'Leabhar Breac Project' is an initiative to produce a diplomatic

Prof. Tomás Ó Cathasaigh, Prof. Pádraig Breatnach and Prof. Catherine McKenna on the occasion of Prof. Breatnach giving the John V. Kelleher Lecture at Harvard University in October 2012.

edition of the entire contents of a 15th-century manuscript, availing of the digitised images of the original manuscript on the School's ISOS website. Leabhar Breac is one of the most extensive of all Irish manuscripts written by a single scribe. In addition to providing a printed edition, the project will create a large database of Early Irish texts serving as an essential research tool for scholars internationally. (3) 'Irish Handwriting in the 17th Century' is a pilot palaeographical project to document the development of Irish script drawing on all the extant monuments from the period studied including those available on ISOS.

The global impact of research located in SCS has been highlighted by successive External Review Panels. Publications of SCS are in constant use in Celtic Studies courses throughout the world. Its publications programme is self-financing and some three thousand volumes have been sold since 2004, generating sales income of approximately €250k. SCS's extensive publications portfolio includes such multi-volume source works as D. A. Binchy's *Corpus Iuris Hibernici* and H. Wagner's *Linguistic Atlas and Survey of Irish Dialects*. Recent titles such as *Early Irish Farming* (Fergus Kelly), which gives an account of pre-Norman farming in Ireland, have been reprinted several times and have proven to be of significant interest to general readers.

SCS's publishing schedule also embraces an expanding range of online research publishing for world-wide access, as represented by the project portal for BILL (Bibliography of Irish Philology and Literature), and various important databases. The School will continue to publish its highly-respected biennial learned journal Celtica, which is also available online (volume XXVII due to appear in 2012).

An important part of SCS's outreach is the requirement to schedule an annual statutory lecture open to the public at which large audiences attend. Recent titles in the Statutory Lecture series are: 'The Four Masters and their Works: A Team Enterprise' (Professor Pádraig Breatnach); 'Women's rights and duties in early Irish law with special reference to marriage' (Professor Fergus Kelly); 'The Bardic Poetry Database: opportunities and challenges for future scholarship' (Professor Damian McManus); 'Poet and scholar: The education of the *fili* in early medieval Ireland' (Professor Liam Breatnach).

SCS fulfills an important training role in offering scholarships to students ('O'Donovan Scholarships'); in providing a continuous weekly seminar programme; and in hosting the flagship annual Celtic Studies Conference (Tionól), which draws contributions from scholars from Irish universities and from abroad. SCS also hosts a triennial International Summer School in Medieval and Modern Irish, and all courses are taught by research staff from the School. Last held in 2011, the Summer School drew large numbers of scholars young and old from many countries (Australia, Austria, China, England, Israel, Italy, Norway, Russia, Scotland, United States of America and Wales). The next International Summer School is due in 2014.

SCS is committed to attracting applications from gifted young Irish and international doctoral and postdoctoral scholars to avail of its scholarship programme and to participate in its International Summer School.

A Visitors' Programme facilitates scholars engaged in research in Celtic Studies from institutions in Ireland and elsewhere in Europe, North America and Australia. Many visitors availing of the School's

outstanding specialist Celtic Studies Library are former scholars of SCS or researchers whose work SCS has published. The School will continue to provide excellent facilities for advanced study and research for university professors and lecturers on leave of absence from academic duties.

School of Theoretical Physics

The task of the School is the elucidation of the mathematical principles of the laws of nature. This concerns both the fundamental laws, which act at very small distances and the emerging laws of large physical systems. On unpredictable occasions this search for knowledge has major economic implications.

At present the most important new data about the fundamental laws come from cosmology and certain other areas of astrophysics and from the Large Hadron Collider at CERN. The discovery of the Higgs particle was recently announced. This will be the final verification of the standard model, which incorporates all known physical laws, and at the same time the start of the exploration of new physics. New physics must be present for both mathematical and astrophysical reasons. On the one hand the standard model is mathematically inconsistent and cannot apply for collisions at the highest observed energies, on the other hand most of the matter in the universe is known to be different from anything which has been studied in laboratories (dark matter).

Preliminary results for the mass of the Higgs yielded a value close to 125 GeV. This is an indirect but strong hint that a supersymmetric extension of standard model physics will be discovered at the Large Hadron Collider. Supersymmetry predicts that each known particle has a partner of opposite statistical behaviour. Such partners may well constitute the bulk of the dark matter. According to supersymmetry, each pair of partners starts with similar properties at short distance, but at some larger distance a breaking of supersymmetry must set in to explain why one partner is more elusive than the other. One of the most important mathematical discoveries at DIAS was a supersymmetry breaking mechanism published in 1975 by L. O'Raifeartaigh, Senior Professor of the School. The international physics community now considers this mechanism as the most likely one to be realised in nature, if supersymmetry is at all relevant. If the preliminary data from the Large Hadron Collider will be confirmed, the study of supersymmetry will remain a core research area of STP for many years to come.

The discovery of supersymmetric partners of ordinary matter will be a major step in the history of physics, but the problem of mathematical

Prof. Peter Higgs and Prof. Tigran Tchrakian at a conference in honour of Prof. Werner Nahm, Director of School of Theoretical Physics.

inconsistency will just be pushed to higher energies and not out of sight. At those higher energies a new world of hidden particles must open up, which may have their source in the physics of a spacetime with extra dimensions. Candidates are superstrings in ten dimensions or supermembranes in the eleven-dimensional setting found by one of the current Senior Professors at the School. At present it does not seem feasible to study these high energies directly, but their mathematical investigation will proceed.

Unexpectedly, this mathematical investigation has found structures which may also apply to the emerging laws of certain special states of matter which can be realised in the laboratory. The properties of those states can only be understood due to quantum mechanics. The first director of the School described a crucial feature by what became known as Schrödinger's Cat, which can exist simultaneously in mutually exclusive states. This opens up the possibility of quantum computers. All current computers use bits which exist in only one of two states at a given time, thus quantum computers can be much more powerful. Quantum computation is technologically very demanding, however, since one look is enough to find the cat alive or dead. One either has to work with systems which are extremely well isolated, or with states which are mutually exclusive, but impossible to distinguish even by hard looks. Due to mathematical developments made in the context of string theory and due to discoveries in low temperature physics, there are now strong indications that such states exist.

The School plans to collaborate with scientists of other countries with the aim to realise a quantum computer based on these ideas. Quantum information will remain another core research area of the School. In the coming years we shall continue and increase our efforts to convince all interested parties that this area deserves support, both in the pursuit of knowledge and for economic reasons.

The Schools of Cosmic Physics and of Theoretical Physics have asked for a single site in order to enhance the common study of newly discovered fundamental processes in the universe. STP will build on existing contacts with leading national and international institutions like the Hamilton Mathematics Institute at TCD and the Max Planck Institute for Mathematics in Germany and develop collaborations with new partners. It will facilitate the work of SCS on 3D documentation of the Ogham stones and explore other interdisciplinary collaborations with those eminent in the physical sciences, the life sciences, and the humanities.

School of Cosmic Physics

SCP takes physics from the laboratory and uses it to address some of the grand challenges we face in understanding our world. How are stars formed? Where and how are cosmic rays produced? What processes occurred early in Earth's history, and are those same processes active today? Why do we have continents and oceans? How does the Earth's crust behave under stress? What resources can we extract sustainably, and how do we deal with waste products? These and similar fundamental open questions drive the School's research.

In Solid Earth studies the Geophysics section of the School is the leading centre in Ireland for the investigation of the fundamental geophysical phenomena that formed our planet. This is based

on complementary observational techniques supported by theoretical considerations and numerical modelling and involves, as well as the classical methods of potential field studies and seismic investigations employed by the School almost since inception, more recently the less-common technique of electromagnetic imaging using magnetotelluric studies, where the section enjoys a world-leadership position. As well as seeking to understand the processes leading to the formation of ocean basins, continents and mountains and the secular tectonic evolution of Earth, such studies are of fundamental importance in the search for natural resources, minerals, oil, gas and, more recently, sources of geothermal energy and for societally important issues, such as monitoring local nature and indeed seismicity, and places for storing industrially-produced carbon dioxide.

New work on ice mask dynamics couples ice movement to land movement leading to superior knowledge of past climatic events. The section houses the Irish National Data Centre for the CTBTO and operates the Irish National Seismic Network.

In Astronomy and Astrophysics, the School is a major centre for the study of star formation (more especially of low mass stars) as recognised by its leadership and co-ordination of the FP7 research training network JETSET and that Professor Tom Ray is a Co-Principal Investigator on the MIRI instrument for the James Webb Space Telescope (the successor to the Hubble Space Telescope). It is also internationally recognised for its work on the theory and phenomenology of high-energy non-thermal astrophysics and cosmic ray physics as demonstrated by its participation in the major international collaborations HESS, KM3NeT, Astro-H and CTA. To provide a focus for this aspect of the work of the School, the Board decided in 2011 to establish a Centre for Astroparticle Physics and Astrophysics (CAPPA) under the leadership of Professor Felix Aharonian who is one of the leading international astronomers in this rapidly developing field.

To carry out its work in both geophysics and astrophysics, the School needs access to powerful computer resources, both for data analysis and theoretical simulations. The School has played a major role in the development of Irish research e-infrastructures through two major PRTLI-funded projects, CosmoGrid and e-INIS, both led by Professor Luke Drury, as well as organising the National Capability Computing consortium. The Irish Centre for High-End Computing owes its origin in large part to these projects and DIAS is committed to continuing its support for this outstanding shared research infrastructure.

DIAS's neutrality and reputation for research excellence has facilitated the coordination and organisation by it of national consortia involving all of the Irish universities. One example of this is the area of Geosciences where DIAS is directing and co-ordinating the establishment of a robust, holistic, broad-based training programme for postgraduate students, the Irish Geoscience Programme (IGGP, www.iggp.ie) wherever they are registered for their fourth-level degree on the island of Ireland. The IGGP was established in 2010 and involves six universities, one research institution (DIAS) and the two geological survey agencies. This example illustrates the leadership role in shared services that DIAS can play at national level, thereby avoiding the pitfalls of

sub-critical delivery of knowledge and the unnecessary duplication of resources. A key factor in this role is the view of DIAS as a partner with, but not a competitor to, the Irish universities.

During the period covered by this plan, DIAS will explore opportunities for similar initiatives in other areas, for example in Astrophysics. The role of Astronomy in attracting students into the study of physical sciences is now universally recognised and all of the Irish universities offer some instruction in Astronomy. In general, the universities employ at least one astrophysicist or astronomer on their teaching staff. However, none of the universities can offer the breadth of coverage needed for a comprehensive graduate programme. DIAS is ideally placed to co-ordinate a national approach to establishing an Irish Astrophysics Graduate Programme.

Dunsink Observatory has the proud tradition as the oldest research facility in Ireland, and can justly boast of its association with Ireland's greatest ever mathematician, Sir William Rowan Hamilton. Since DIAS was given custody of the Observatory in 1954 it has sought to develop societal engagement through Open Nights for the public. In recent years this has been expanded to include a broader range of activities with the main building being renovated to provide an enhanced visitor experience. Dunsink also provides accommodation for visiting academics. This facilitates the establishment and maintenance of strategically important international partnerships. It is proposed to expand the range and number of outreach events that will be hosted at Dunsink.

The Seismology in Schools initiative is an important contribution to promoting science in schools. Fifty-five primary and secondary schools are currently participating in the initiative, as well as three GeoParks and various other institutions. The schools use a rudimentary "garden gate" horizontal motion seismometer and associated software, delivered through the programme, to record and study in real-time small local events and large distant earthquakes wherever they occur globally. When there is an earthquake of interest, whether a local one (offshore Mayo in May) or a major global one (Japan) some 35,000 Irish schoolchildren are exposed first-hand to physics, mathematics and the geosciences. The experience of the Seismology in Schools programme confirms the view that when science is relevant, learners become more engaged, in particular when they see how science is reflected in the reality of their own lives and in what they read in the media.

Registrar, Mr Cecil Keaveney, Director of School of Celtic Studies, Prof. Pádraig Breatnach, Senior Prof. Alan Jones, School of Cosmic Physics, Mr. Tom Blake, Director, Irish National Seismic Network, Ms. Elizabeth Abela Hampel, Dr. Vincent Cunnane, Chairman, Dublin Institute for Advanced Studies, Executive Secretary of the Preparatory Commission for the CTBTO, His Excellency Mr. Tibor Tóth at the launch of CTBTO.

RESEARCH IMPACT

In accordance with its vision statement, which commits DIAS to carrying out research of global impact that is capable of significantly advancing human understanding, the research strategy of all three Schools will continue to focus on deep fundamental research with long-term impact. This strategy has proven very successful in the past. In Theoretical Physics the full impact of Synge's marriage of geometry and relativity was not appreciated until several decades after his work, but it had a profound influence on the subsequent work of Penrose and Hawking on black holes and the geometry of the universe. In Celtic Studies, D.A. Binchy's monumental multi-volume edition of the corpus of early Irish law texts has profoundly changed perceptions and understandings on all aspects of early Irish history and society. In Cosmic Physics, basic work by Jacob and collaborators on the formation of the Atlantic Ocean led directly to a radical reclassification of the Rockall and Porcupine basins as part of the Irish continental shelf with the result that Ireland is successfully having vast tracts of the Atlantic area defined as its national territory under Law of the Sea. There is every reason to believe that this strategy will continue to be successful in the future. It has the further advantage, at a time when the rest of the research system is becoming increasingly dominated by applied research and prioritised short-term targets, of clearly differentiating DIAS within the national research landscape. The primary motivation for research in DIAS should remain the intrinsic interest and importance of the research itself and its potential for long-term impact on knowledge, but always with consideration to activities that may yield short-term impact.

DIAS acknowledges recent progress aimed at improving the quantification of research output in Ireland. As a consequence of its uniquely focussed mission and the tailored support for the research endeavour, DIAS delivers outstanding value for the State's investment in terms of continuous research output. The Forfás report "Research Strengths in Ireland: a bibliometric study of the public research base" November 2009 is the most recent bibliometric analysis of Ireland's research output and it highlights the outstanding achievements of DIAS research staff. The growth in the quantity of research publications was unmatched by any other research institution in the State, while the impact factor, as measured by citation levels, is evidence of the quality of DIAS research. The outcomes give confidence that the research ecosystem at DIAS is highly effective at generating output that is well in excess of national norms.

Over the period covered by this plan DIAS will place a greater emphasis on the exploitation of research investment and, by working in partnership with other institutions, create closer links between its research activities and the national knowledge transfer and innovation agenda. In looking to the future, DIAS is committed to sustaining the required critical mass in each of its constituent Schools. This will be achieved through increased participation in research programmes where peer-reviewed competitive funding is available and through seeking philanthropic support for additional research fellowship and scholarship awards.

GOVERNANCE AND MANAGEMENT

Background

While it is far from unique in an international context, DIAS is unique in Ireland in having a statutory mission focussed on the provision of an optimal environment for fundamental research and scholarship and the advanced training of scholars at the highest level. DIAS neither grants nor validates degrees, nor has it any statutory responsibility for teaching undergraduate students. It is the only institution in Ireland with an exclusive focus on postgraduate and postdoctoral training. DIAS has a distinct, unique and valuable mission supported by an administrative and governance structure adapted to its needs. The DIAS mission requires a funding model and governance structure different from universities with their multiplicity of purposes.

DIAS has a formal link to two Dublin-based universities through the structure of its Council. However, DIAS cooperates with all seven Irish universities in both research and postgraduate studies. It has been successful in forging important links with other international institutions and researchers and in providing a forum within which staff and scholars from universities and research bodies can meet and work together. It is the intention of DIAS that these relationships, which make a major contribution to the scale and quality of research in Ireland, should be preserved and strengthened.

Current Structure

Consistent with the vision of its founders, DIAS continues to benefit from a direct reporting relationship with the Department of Education and Skills. This relationship reflects the basic research-focussed mission of DIAS and is consistent with international best practice whereby Institutes for Advanced Studies are regarded as entities that relate to, but are distinct from the higher education sector or focussed research.

The Council of DIAS, its body corporate, is responsible for the general governance of its financial and administrative affairs. The membership of the Council is set out in the 1940 Act and comprises a Chairman appointed by the President of Ireland, on the advice of the Government, three ex-officio members, viz. the Provost of Trinity College Dublin, the President of University College Dublin and the President of The Royal Irish Academy, and six members appointed by the Governing Boards of the three Schools (according to precedent comprising of the Chairman of each Board and the Director of each School).

Each School has an independent Governing Board with responsibility for the research direction of the work of the School. The relationship between the Council of DIAS and the Governing Boards of the Constituent Schools is defined in the 1940 Act and has worked well. This is due, in no small measure, to the pragmatic approach of the Chairpersons of Council and of the School Boards. A review of DIAS's governance structures will be carried out in order to ensure that they remain fit for purpose. The review will be carried out during the period covered by this plan.

The regulation of the conduct of DIAS's business, which has academic leadership at its core, is founded on principles that include accountability, transparency, probity and integrity. In the context of our values of collegiality and inclusivity, the review of governance and management will focus on ensuring that the highest standards apply in every aspect of our operations, while at the same time preserving the values of creativity and intellectual autonomy which are DIAS's lifeblood.

Staffing and Funding

Currently there are 61 staff and 31 scholars working at DIAS. These include positions funded from external research grants. DIAS receives an annual grant from the Exchequer and it also secures external project funding from national, European and international research funding agencies as well as other non-exchequer sources. The Exchequer Grant received in 2012 was €6.856m (2011 – €7.020m). Additional project income secured in 2011 amounted to €2.451m (2010 – €3.104m). Further details on staffing and funding are set out in Appendices 2, 3 and 4.

COMMON STRATEGIC ISSUES AND INITIATIVES

(a) Background

In setting out the future vision for DIAS, its statutory responsibilities must remain central to its activities. However, it is also recognised that there has been a fundamental change in the research environment in Ireland and internationally in the period since DIAS's foundation, and more especially in recent years. This Strategic Plan is being prepared at a time of global economic downturn, a downturn that has been particularly acute in Ireland. During the last few years Exchequer funding has been reduced year on year. Yet, simultaneously, society wants and expects all state-funded entities to deliver more, in terms of output, economic and/or societal impact and relevance. If DIAS is to continue to enhance its international reputation, it must expand the scale of its activities and the resource base. The DIAS community must apply its collective mind to securing funds from diverse income sources. These include State and EU research programmes together with philanthropic sources and where appropriate funding from industry. Crucially, DIAS must ensure that these funds are spent on improving the quality of activities, always acting in accordance with its core values. The initiatives set out in this Strategic Plan are focussed on positioning DIAS to deliver on this objective.

(b) Collaboration

The strategies adopted by DIAS reflect not only statutory responsibilities but also a determination to participate fully in appropriate national policies, priorities and funding programmes. In this manner, DIAS will expand its own research capability and provide opportunities for staff to engage in collaborative projects with Irish universities and other research organisations. DIAS will also increase participation in research programmes that are funded by agencies or bodies outside Ireland, thereby allowing existing international collaborations to flourish and new arrangements to be established. Where appropriate, DIAS will play a leadership role in national initiatives in research and advanced training, will co-ordinate national activities and act as the primary hub linking Irish researchers to global networks of research excellence.

(c) Independence

A factor which experience has shown to be crucial to the success of DIAS is its institutional independence and administrative autonomy. Due to its exclusive focus on scholarship and research, and because of its trusted independence and neutrality, DIAS can facilitate partnerships and linkages which it would be difficult, for an organisation subject to manifold funding and policy constraints, to develop.

Prof. Felix Aharonian, School of Cosmic Physics, Prof. Luke Drury, Director, School of Cosmic Physics and President of Royal Irish Academy and Prof. Denjoe O' Connor, School of Theoretical Physics, on the occasion of the election of Professors Aharonian and O'Connor to membership of the Academy.

(d) Visitors

In line with other comparable research institutes, an increase in the level of funding that is available for visitors would benefit the research environment of the Schools. We will seek to provide additional funds for inviting at least one long-term visitor per School per year. This could take the form of bilateral agreements between DIAS and a relevant university with DIAS paying an agreed portion of the salary of the Visiting Professor.

(e) External Review

The commitment to world-class research is a core strength of DIAS and is evidenced by the procedures for external review that have been adopted by the Schools. As part of the process each School is reviewed by separate panels of international experts. The initial reviews were first carried out during 1994 well before the practice was broadly adopted in Ireland. The reports, which commented favourably on the research activities of the Schools (see Appendix 7 for excerpts from the most recent reviews in 2009 together with the membership of the review panel for each School), also contained a number of recommendations which the Council of DIAS has worked with the School Boards and the administration to implement. DIAS will continue to review its research in this way throughout the period of this Plan.

(f) Publicity

To complement the above strategies there will be an increased focus on publicising the role of DIAS and the results of its research and outreach e.g. SiS, ISOS, CTBTO, INSN, CAPPA. In recent years there has been an improvement in the level of exposure given to DIAS in the national press, radio and television. Nevertheless, stakeholders, who include taxpayers, researchers, policy makers, industrialists and legislators, may only be aware of a small segment of the work and successes of DIAS. As a result, the work of the research staff does not always achieve the appropriate public profile, especially within Ireland. Every effort will be made to address this public information deficit during the period of this plan.

(g) Buildings

The accommodation problems at DIAS are a matter of ongoing concern. It is clear from the reports of the External Review Panels and the findings of internal reviews that the work of DIAS would be enhanced if suitable single-site accommodation could be provided to facilitate co-location of the three Schools and Administration. In order to address the problem, DIAS and the Office of Public Works carried out a detailed review of its needs and examined a number of potential sites. DIAS will continue discussions with both the Office of Public Works and the Department of Education and Skills with a view to resolving this issue.

(h) Appointments

The existing appointment procedures can lead to delays of up to twelve months between approval in principle and actual appointment to posts. This problem is particularly acute for senior level posts. During the term of this plan, DIAS will seek the agreement of the Department to the implementation of a revised appointment procedure that will provide greater autonomy and streamline the process for making senior appointments.

(i) Charitable Foundation

The DIAS Charitable Foundation will be established with the objective of seeking philanthropic contributions from private sector donors and foundations to support the work of the Institute.

(j) Administration

DIAS has evolved a highly efficient and cost-effective support system for research and scholarship. This ensures that funding received is to the greatest extent possible invested in direct research related expenditure. Currently over 66% of income is allocated to direct research expenditure which establishes DIAS as one of the most cost-effective organisations for the utilisation of state research funding. The management of DIAS will continue to focus on cost-effectiveness and intends to progressively reduce the share of DIAS's budget allocated to administration.

School of Theoretical Physics Statutory Public Lecture November 2011.

STRATEGIC PRIORITIES

DIAS has the following strategic priorities for the period covered by this plan:

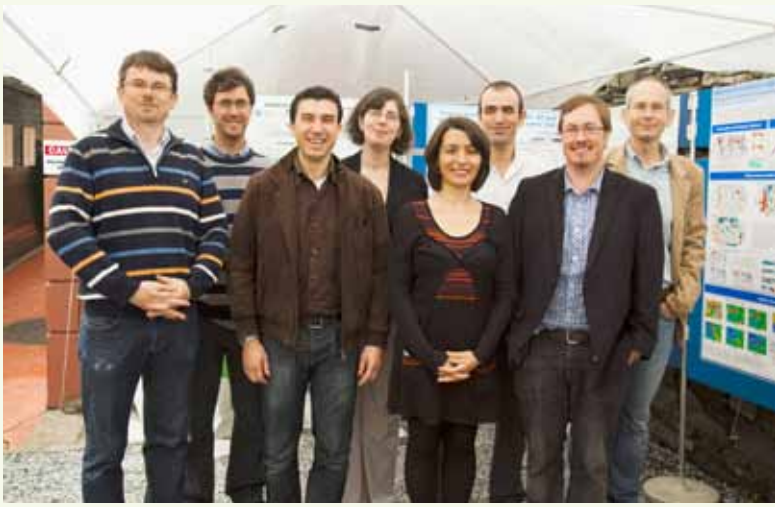
- In the sciences, to understand star formation, the nature of cratons, the origin of cosmic rays, the nature of dark matter and its possible connection to supersymmetry, the potential of quantum information theory and computing
- In Celtic Studies, to complete the critical editions and monographs projected as part of this Strategic Plan and to vigorously pursue the objectives of the separate components of the School's Digital Manuscripts Initiative
- To develop new models for collaborative research
- To give due attention to issues of succession planning within the Schools
- To establish, when appropriate, new Schools in emerging areas that represent academic and societal opportunities
- To co-locate the Schools and administration in a single building on a suitable site
- To maintain the independence and administrative autonomy of DIAS
- To diversify the sources of research funding
- To strengthen collaborative relationships with national and international partners
- To continue to promote research quality through the system of external evaluation
- To establish the DIAS Charitable Foundation to raise philanthropic support
- To expand Outreach and Public Engagement
- To keep under continuous review the efficient administration of DIAS

Prof. Bernard Julia, Director of Research at Department of Physics-École Normale Supérieure and Prof. Michael Tuite, School of Mathematics NUIG.

MONITORING OF RESEARCH PERFORMANCE

Key performance indicators have been identified to assess research potential and monitor the research activities in DIAS:

- Quantity and quality of publications in international peer-reviewed journals and books and their impact
- Numbers of intra- and extra-institutional research collaborations
- Presentation of the results of research to international audiences
- Securing research funding from national and international funding agencies which require peer review in the selection process
- Ability to attract outstanding staff and researchers
- Receipt of national/international awards
- Growth in critical mass of research teams
- Staff membership of research proposal evaluation panels
- Hosting of international researchers
- Membership of National and International Research Policy Agencies
- Membership of the editorial boards of international scientific and scholarly journals
- Membership of learned societies
- Invitations as peer reviewers for grants and publications



Geophysics students and researchers at the launch of CTBTO.

FUNDING

The level of resources available during the period of the Strategic Plan is a critical factor in determining the ability of DIAS to fund the initiatives identified in this document. At present the majority of income comes from funds voted annually by the Oireachtas to the Department of Education and Skills. While DIAS will continue to rely mainly on public funding we recognise that the current state of the national finances is such that the level of such support is unlikely to increase. Therefore, the Council, in consultation with the School Boards, will over the next five years explore additional opportunities to increase the amount of income generated from non-exchequer sources. This will include funding from national and international competitive peer-reviewed programmes and philanthropic support for the work of the Institute.

Chairman of School of Cosmic Physics Governing Board, Prof. Gerry Wrixon, Tánaiste Eamonn Gilmore T.D., Director of the International Data Centre, Dr. Lassina Zerbo and Mr. Tom Blake, Head, National Data Centre, CTBTO, Ireland, at the launch of CTBTO.

CONCLUSION

DIAS will respond in a flexible, creative and collegial manner to the challenges and opportunities that will arise during the period 2012 to 2016. This Plan sets out our commitment to excellence in research, training and scholarship as the key priority and the defining characteristic of DIAS. It also signals an intention to develop additional strategic partnerships both nationally and internationally in order to enhance the impact and reputation of DIAS. At present DIAS is meeting a number of Irish universities with a view to entering appropriate collaborative agreements. These will strengthen existing arrangements that are in operation between some of the Schools and individual Departments in the Universities.

The initiatives outlined in this document reflect the ongoing commitment of DIAS to safeguard and improve standards of research, scholarship and publications. Measures are also included that will assist DIAS to compete for funding both nationally and in the global research environment. A key aim is to achieve critical mass in our activities by retaining, attracting and developing world-class principal investigators who will enhance the international reputation of Irish research. This will confirm DIAS's standing as a key national asset by virtue of the excellence of the research and scholarship that it produces.

This Strategic Plan describes the potential of DIAS to contribute to the implementation of the national research agenda thereby accelerating the country's progress towards a knowledge-based society. DIAS is committed to constructive engagement with the Department of Education and Skills, other stakeholders and state agencies to ensure that it continues to make a significant contribution to Ireland's reputation as a location where globally significant research is carried out.

Solarfest June 2011, Dunsink Observatory.

APPENDIX 1
PROGRAMME OF SCHOOL ACTIVITIES

SCHOOL OF CELTIC STUDIES

RESEARCH PLAN 2011-16

The present Research Plan is the product of advisory meetings held in March 2011 with Staff of the School (Appendix 1) and has been drafted to accord with guidelines on the functions and research remit of the School as laid down in the Statutory Rules and Orders of the Institute for Advanced Studies Act (1940) (no. 13.5 (1), (a)-(l).

The following documents were consulted: (i) Plean Taighde 2006-10; (ii) 'Review of the School of Celtic Studies 18-19 June 2009') (recommendations) (Appendix II).

(a)

MANUSCRIPTS

1. ISOS

By enabling instant access to multiple manuscripts from different libraries world wide digital technologies have transformed the context in which textual scholars and palaeographers conduct their research. SCS, DIAS, is in the forefront of innovative research using digital technologies in the field of Irish manuscript literature and script history.

The 'Irish Script on Screen' (ISOS) project was established in SCS in 1999. The long-term objective is to provide high-resolution images of all Irish-language manuscripts in their entirety from cover to cover and to make these available on the world wide web as a virtual library of manuscripts from the 7th to the 19th century. The project has been developed with the agreement and cooperation of manuscript libraries in Ireland and abroad. Professor Pádraig Ó Macháin has directed the project from the outset taking charge of the project website www.isos.celt.dias.ie and dealing with inquiries, licences and the generation of images, and taking responsibility for the development of collaborative agreements with outside libraries. Anne Marie O'Brien, technical assistant, is the project photographer and image-processor and maintains the project archive. The quantity of images presently being displayed online is almost 50,000, and the ISOS website receives approximately 2,500,000 hits annually.

The collaborative arrangements already operational between the School/ISOS and the Royal Irish Academy, National Library of Ireland and National Library of Scotland will continue to be developed. Some 60 manuscripts from the RIA collection have been scanned and processed to date, ranging from the early Christian period (Stowe Missal) to the mid-16th century. In the immediate term it is hoped to focus mainly on the digitisation of RIA manuscript holdings up to the end of the 17th century. Arrangements are in place also to return in the near future to the National Library of Ireland to continue the digitisation of Irish manuscripts so as to include all holdings of the 17th century. Pursuant to a collaborative agreement with the National Library of Scotland (Edinburgh) 37 manuscripts have been scanned and digitised from that collection to date. The images are on display on the ISOS website in conjunction with catalogue descriptions prepared by Dr Ronald Black who kindly agreed to the digitisation and display of materials from his 'Catalogue of Gaelic manuscripts in the National Library of Scotland' (2011). Plans are ready to digitise further manuscripts from this collection in the near future. Agreement with the library authorities in University College Cork was reached in 2010 which has resulted in the completion of

"...the work of the School is of great importance not only to Ireland but internationally and not narrowly to Celtic Studies but to linguists, historians, medievalists and scholars of other disciplines".

Celtic Studies Board *Standing: Pictured from left to right:* Prof Malachy McKenna DIAS, Dr Uáitéar Mac Gearailt, Professor Ruairí Ó hUiginn, Prof. Fergus Kelly DIAS, Prof. Ailbhe Ó Corráin, Nollaig O'Muraile, Dr Máire Ní Mhaonaigh. *Seated: Pictured from left to right:* Prof. Pádraig Breatnach DIAS (Director of School), Prof. Anders Ahlqvist (Chairman of Board), Prof. Liam Breatnach DIAS, Dr Eilís Ní Dhea, Prof. Máire Herbert. *Absent:* Dr Katherine Simms, Prof. Jim McCloskey.

digitisation of five manuscripts to date. Arising from this collaboration, UCC invited Professor Ó Macháin in 2011 to arrange for the creation and processing by ISOS of images of the 15th century codex, the Book of Lismore, for display at a major exhibition of the privately-owned manuscript in the Glucksman Gallery, UCC, and to provide scholarly descriptions as part of a touch-screen guide to the exhibition. It is anticipated that these images will be mounted on the ISOS website in due course. The collaboration with UCC is ongoing and additional manuscripts from the Boole Library collection are presently being digitised by ISOS. Agreement has been reached in principle with the library of Trinity College Dublin to continue with the work of digitising the Irish-language manuscripts of which a sizeable number (mainly medical manuscripts) are already installed on ISOS.

An important aspect of the work of ISOS in recent years which it is intended to develop and expand in the period of this research plan has been the organisation of specialist day-long conferences aimed at creating international links with similar projects abroad and presenting to a wider audience the results of the academic work on manuscripts chosen for digitisation in SCS, such as the Book of the O'Conor Don which was the subject of a symposium in 2010 of which the proceedings have since been published as *The Book of the O'Conor Don: Essays on an Irish manuscript*.

2. Manuscript Catalogues

(a) *Catalogue of the Irish manuscripts in the library of Trinity College, Dublin. Fasc. I: Medical manuscripts* (Dr Aoibheann Nic Dhonnchadha). 32 manuscripts in all are to be catalogued in

this fascicule; mainly vellum and dating from between 1400-1700. Dr Nic Dhonnchadha has so far completed a comprehensive catalogue of 22 of these manuscripts (subject matter and physical description) and her digitised descriptions are now installed on the ISOS website in conjunction with the manuscript images (2010-11). Full descriptions of the remaining manuscripts will be completed for installation by the end of 2012. A revision with some abbreviation of the entire body of descriptions will be effected in 2013 and this is scheduled to be published with indices in 2014. (b) *Catalogue of Irish manuscripts in the National Library of Ireland* (Pádraig Ó Macháin).

3. Leabhar Breac Project

Professor Liam Breatnach instituted and is director of the project which has been developed with the collaboration of Bergin Fellows Dr Roisin McLaughlin and Dr Clodagh Downey and successive O'Donovan Scholars of the School together with postgraduate scholars from Trinity College Dublin. The aim of the project is to provide a diplomatic first edition of the entire contents of this important 15th century manuscript online and in printed form. The Leabhar Breac is one of the most extensive of all Irish manuscripts written by a single scribe. It contains a very large number of highly important texts in Irish and Latin from the Middle Ages (280 pp.). In providing an online edition of the complete manuscript this project will also create a large database of early Irish texts serving as an essential research tool for scholars internationally. More than one sixth of the manuscript has been edited to date (50 pp.) and it is anticipated that this will be made available online in the near future. As the project proceeds more IT technical assistance will be required to ensure regular updating of the database.

4. Manuscript studies and palaeography

(i) The School expects to publish The Four Masters and their manuscripts (Pádraig Breatnach) in 2012; this is a collection of studies with appendices incorporating a revised and annotated version of the author's statutory lecture of 2008 ('The Four Masters and their works: a team enterprise'). (ii) 'Irish handwriting in the 17th century' (Pádraig Breatnach) is a newly-instituted pilot palaeographical project to document the development of Irish script drawing on all the extant monuments from the period studied including those available on ISOS. It will lead to the production of a virtual collated inventory of 17th century scribal hands. (iii) Arising from his work on the ISOS project Pádraig Ó Macháin will publish the results of research on various manuscripts that merit more attention than has been accorded them to date, including 'Leabhar Fhearghail Uí Ghadhra (23 F 16)', 'The manuscript of Tadhg Ó Cianáin (A 21)' and 'Queen Elizabeth's Primer (Christopher Nugent)'. He is also engaged in making digital transcriptions available on line to accompany the ISOS images of the 'Book of the O'Conor Don'. (iv) Aoibheann Nic Dhonnchadha will shortly publish descriptions of two important medical manuscripts, viz. National University of Ireland, Galway, MS 175 (paper 16th cent.), which is the oldest manuscript in the NUIG collection and National University of Ireland, Maynooth, MN C 110 (vellum 15th cent., scribe Eóin Ó Callanáin).

BARDIC POETRY

(i) Pádraig Ó Macháin will continue with the series of editions of unpublished poems by Fearghal Óg Mac an Bhaird for publication in the journal of SCS, *Celtica*. (ii) Pádraig Breatnach is scheduled to complete his editorial project, *Chronicle Poems of the Nine Years' War* in 2013; other classical poems

due for publication are as follows: *Cuirfead ionnad a Aodh* (Eochaidh Ó hEódhusa); *Fulang annró adhbhar sóidh* (Ruaidhrí Ruadh Ó hUiginn).

MEDICAL TEXTS

Publications in preparation by Dr Aoibheann Nic Dhonnchadha which are due for completion within the period of this plan are as follows: (i) 'Idraforbia'. This is an edition of a text on idraforbia which is found in MS G 11 (Nat. Lib. of Ire.) and is based on a chapter from Gilbertus Anglicus, *Compendium medicinae*. (ii) New edition of a list of herbs found in the John Rylands University Library, Manchester, MS Irish 35, ff. 117r-118v (previously published by Stokes in Archiv f. *celtische Lexicographie* I.) Stokes was mistaken in his view that *lemmata* were omitted by the scribe. (iii) Edition of the Irish translation of the medical textbook *Isagoge Iohannitii* from 23 N 16, ff. 56r-58v (unique copy from 1592) together with an English translation. (iv) 'Medical writings in Irish: translations of the works of Bernard of Gordon'. This will discuss three works translated into Irish in the 15th century.

EARLY IRISH LAW

(i) Professor Liam Breatnach will continue the edition of *Córus Bésgnai* and expects to complete it within the period of this research plan. He is also engaged in editing *Bretha Nemed Toísech*, one of the longest and most complex of our legal texts (the first third was published in Ériu vol. 40 (1989)). Both editions will be published in the *Early Irish Law Series* (School of Celtic Studies). (ii) Professor Fergus Kelly expects to complete his edition of the legal treatise by Giolla na Naomh Mac Aodhagáin, *A Legal Treatise by Giolla na Naomh Mac Aodhagáin* (Binchy, *Corpus Iuris Hibernici* 691.1-699.4) for submission to external readers in 2012. In addition he will complete an edition with translation of an Old Irish text on legal disputes within marriage (*Corpus Iuris Hibernici* 144.5-150.16) for inclusion in vol. 27 of Celtica (2012).

EARLY AND MODERN IRISH TEXTS

(i) Fergus Kelly will undertake a new edition of *The Triads of Ireland (Trecheng Breth Féne)* beginning in 2012. Transcriptions from the manuscripts are complete. (ii) Pádraig Breatnach will continue to edit unpublished 18th century poems for the series 'Togha na hÉigse 1700-1800' to appear in *Celtica* (no. 6 published in *Celtica* vol. 26; the series was formerly published in Éigse).

ELECTRONIC PUBLICATIONS

SCS intends to expand its electronic publishing program. (i) Pádraig Ó Macháin will continue his planned complete transcription of the Book of O'Conor Don to accompany the manuscript images on ISOS (ff. 1r-73r are on the website to date). (ii) The 'Irish bardic poetry database' prepared by Professor Damian McManus and a team of scholars from Trinity College Dublin has been made available for installation on SCS. This will complement Dr Katharine Simms's database already available online by providing the text of some 2,000 poems from published and unpublished sources. Once all outstanding copyright issues have been clarified the database will be rendered searchable and it is hoped will provide an outstanding resource to scholars world-wide. (iii) During the period of this research plan it is proposed that as part of the *Leabhar Breac* Project the complete diplomatic text will be installed online in stages to accompany the manuscript images. (iv) A draft-index of verse firstlines corresponding to the *Catalogue of Irish manuscripts in the National Library of Ireland*, fasc. I-IX has been prepared by Dr Andrew McCarthy (IT

technical assistant to the School) and this will be made available electronically in the near future. (v) SCS is engaged in discussion with the School of Languages, Queen's University Belfast, with a view to preparing a digital edition of the *Linguistic Atlas of Irish Dialects* (H. Wagner).

(b)

GRAMMAR AND LEXICOGRAPHY

(i) Liam Breatnach will continue to prepare *A Grammar of Middle Irish*. (ii) SCS will continue to collaborate with the Centre National de la Recherche Scientifique in the publication of *Lexique étymologique de l'irlandais ancien* (1959-). Letter A-D and M-U have been published by the School, and Professor Pierre-Yves Lambert is currently preparing the letter E. (iii) Aoibheann Nic Dhonnchadha expects to complete the following studies in the period of this research plan: (a) 'A note on *Regimen na sláinte*, lol. 8335-41' (the meaning of the phrase massa *ptisanaria*, and examples of the Irish form 'in mais tisinarda' from various texts); (b) 'A ghost-word [*tapairis*] in DIL'; (c) 'Roinnt focal ó *Almusór* Thaidhg Uí Chuinn (fl. 1400-15)' (a conspectus of the large number of words from the *Almusór* not mentioned in *DIL* with account of the context of their use). (d) The School expects to receive the revised final version of the edition of *Vocabularium Latino-Hibernicum* (Seán Ua Súilleabháin) in 2012.

(c)

IRISH DIALECTS

(i) Malachy McKenna hopes to finalise his monograph on the Irish of Rann na Feirste for submission to the publications committee of SCS in Spring 2012. (ii) *The Survey of Spoken Irish in the Aran Islands, Co. Galway* (Séamas Ó Direáin) (1000 pp) is currently being assessed by the publications committee of the School (November 2011). (iii) Dr Brian Ó Catháin's edition of *The Irish of East Mayo* (T. J. Lavin) will be submitted to the publications committee in August 2012.

The report on SCS by the External Review Panel (2009) drew attention to the special urgency attaching to the furtherance of study of all aspects of Irish dialects as part of the work of the School. The Panel recommended that a strategy for study of the spoken language be developed to include training for younger scholars (parg. 18 '...that consideration be given to the inclusion in the next Strategy Statement of an integrated plan for the School's investigation of the spoken language, and for the training of younger scholars in this area'). It is a matter of great concern to the School that the personnel resources required for the development and implementation of such a strategy are currently lacking. Professor McKenna retires in December. A first step towards addressing the present emergency in the study of the spoken language would be that one scholarship from the O'Donovan Scholarship scheme be publicised with the condition that the portfolio of candidates' research interests should include the study of the spoken language in a Gaeltacht area.

GLOR (Gaelic Language Online Recordings)

The project was begun in 2004. The aim from the outset has been to digitise and store on CD all sound recordings of SCS (including DAT tapes) and to make these available together with data concerning speakers, location, date, and to transcribe selected portion for installation on a specialised sound-section of the School network (GLOR). The process of electronic transfer is complete for the older collections (approximately

60 speech hours mainly from districts in Co. Cork and Co. Galway) and cataloguing of the files by Aoibheann Nic Dhonnchadha is ongoing. In 2010 Brian Ó Curnáin undertook on the Director's advice to transfer to digital form materials collected on behalf of the School in Conamara (Iorras Aintheach) during the preceding 20 years to DAT tapes and to transcribe and edit selected material.

(d)

PLACENAMES

This area of study is the remit of the Placenames Office, Ordinance Survey. The publications committee is happy to consider for publication any book on placenames in the field of Celtic Studies submitted to the School.

(e)

HISTORICAL STUDIES

Dr Michelle O Riordan is engaged in research with the title 'Idirghabháil an eagarthóra' dealing with the methods used by historians in drawing on authoritative editions of Irish texts for literary material in Irish. In addition she is working on a study of the evidence for different understandings of Ireland in Irish literature of the 17th and 18th centuries. She will continue work on a comprehensive study of the poetic texts edited by Cecile O'Rahilly in *Five seventeenth-century political poems* (1952).

(f)

CELTICA

The editors are Fergus Kelly and P. A. Breatnach. Vol. XXVII is scheduled for publication in 2012, and it is hoped to return to a pattern of publishing the journal annually. It is anticipated that the number of contributions from staff members will increase in future volumes. As part of the peer-review system in place for the assessment of contributions to Celtica reports are sought from internationally recognised outside experts on all submissions.

OTHER JOURNALS

Staff members regularly contribute articles and reviews to other academic journals including *Ériu, Éigse, Peritia* etc. Professor Pádraig Breatnach was editor of *Éigse: A Journal of Irish Studies* (1986-2010) (National University of Ireland). Professor Liam Breatnach is a co-editor of *Ériu* published by the Royal Irish Academy.

BIBLIOGRAPHY

Alexandre Guilarte will continue his conduct of the bibliographical *BILL* project (*Bibliography of Irish Linguistics and Literature*. The current database is accessible on the School website. In the past five years the number of entries in the catalogue has been increased from 1,751 (September 2005) to 10,300 (2011), and 75% of the material is from journals. All journals whose subject matter is directly linked to BILL have been catalogued and other titles have also been excerpted. Up to 30% of the data (1,707 of 5,524 entries) awaits analytical processing and indexing and this work is progressing. The software has been very much improved in the past five years using LaTeX and HTML to a high standard. In the period of the research plan the main concentration will be on material from monographs and commemorative/ festschrift-type publications; the processing of bibliographical entries from learned journals will be completed; and the project website will continue to be maintained.

A comprehensive index of *Celtica* vols. I-XXVI (+) will be produced within the period of this research plan.

MEDIEVAL AND MODERN WELSH SERIES

Two book-length works are scheduled for submission to the publications committee for inclusion in this series during the period of the research plan, viz. an edition of Math uab Mathonwy (Ian Hughes) and the collection *Medieval Welsh poems to saints and shrines* (B. Lewis).

SCRIPTORES LATINI HIBERNIAE

An edition of the *Collectio canonum Hibernensis* is currently being prepared by Dr Roy Flechner for this series. It is hoped that the final volume of the work *Periphyseon* (Johannes Eriugena) (vol. V) will be ready for publication in this series in 2013 (E. Jeauneau).

Irish Script on Screen.

OGHAM IN 3-D

This is a pilot project initiated by SCS with the cooperation of STP (2009). The project objective is to conduct a comprehensive programme of electronic scanning on all Ogham stones (approximately 400) and to combine the 3-D images in a permanent database which will include transcriptions and scholarly commentary. Discussions are taking place between SCS and the National Monuments Service, Department of Arts Culture and the Gaeltacht, with a view to reaching an agreement on funding which will enable the School (a) to continue processing the images already made of Ogham stones in the National Museum and at locations in the country and (b) to embark on an action programme to scan stones identified as in endangered locations and which are of interest as a tourist resource and are of interest to students of local history.

(g)

TRAINING ADVANCED STUDENTS

O'Donovan Scholarships

Currently the School has four research scholars under this scheme (Dr Helen Imhoff, Dr Anna Matheson, Dr Elliott Lash, Dr Sorcha Nic Lochlainn). Each is assigned a research director, and all benefit from informal advice and assistance from staff members and attend regular seminars and classes. Continuous training in editorial methods is available to those participating in the *Leabhar Breac* project.

Dr Roisin McLaughlin is located in the School as a Fellow of the Irish Research Council for the Humanities and Social Sciences.

Bergin Fellowship

Dr Roisin McLaughlin (2005-10) and Dr Clodagh Downey (2006-11) were the first fellows to be appointed under this scheme. The School benefitted from their scholarly engagement and productivity, and both participated fully in all aspects of the work of the School. One Fellowship has been advertised (final date for applications 30 November).

Summer School in Medieval and Modern Irish Language and Literature

As part of its remit to offer training to advanced students SCS organises a two-week Summer School every three years which attracts a large international attendance. The Summer School includes a wide range of courses in language and literature and all tuition is done by staff of the School. The most recent Summer School (July 2011) had 50 participants from many countries (China, Finland, Ireland, Japan, England, the Netherlands, Norway, Russia, Scotland, USA, Wales). The date of the next Summer School is fixed for July 2014.

(h)

SEMINARS, PUBLIC LECTURES, CONFERENCES

The School will continue to offer in-house seminars based on texts being edited by staff. The Annual Statutory Lecture is traditionally given as part of the programme of the annual Tionól, and this practice will continue. The School will continue to organise occasional one-day symposia on ISOS-related manuscript studies.

(i)

FACILITIES FOR UNIVERSITY PROFESSORS AND LECTURERS

The School will continue to welcome visiting university professors and lecturers and provide every facility for shorter and longer stays, including use of the library.

The Library

The Library which includes a uniquely comprehensive stock in the field of Celtic Studies is managed by the Librarian Margaret Irons with the assistance of Órla Ní Chanainn. The online catalogue is accessed by staff on the intranet, and it is hoped to be able to make the catalogue accessible to outside scholars within the period of the research plan. The electronic holdings of the Library have been greatly expanded and online services will continue to be developed. Space problems will continue to be addressed and every effort will be made to maintain and improve the very high standard of service provided to users.

(j)

BOOKS BY AUTHORS FROM OUTSIDE THE SCHOOL

School staff will continue to spare no effort in editing manuscripts accepted for publication, in advising authors, in reading proofs and in ensuring that the School's publications are to the highest standard at all times.

November 2011

Strategy for the School of Theoretical Physics

The School of Theoretical Physics (STP) has a distinguished research record and includes among its former professors some of the most illustrious names in the history of theoretical physics, including its first Director, Professor Erwin Schrödinger. These outstanding physicists set a standard of scholarship which has established STP's reputation as a world leader in its field. The report of the external review group – *External Review: School of Theoretical Physics, November 2009* commented as follows "..The Panel commends the three Senior Professors presently constituting the permanent staff of the School for carrying out scientific research at an internationally very high level of excellence and endorses their plans for the near future.". This provides assurance that the school continues to carry out research of the highest quality and that the future role of the School, as set out by the Senior Professors and Governing Board, is bright.

STP concentrates on its core tasks of carrying out and publishing original research into the mathematical principles of physics and of training talented postgraduate scholars in research methodologies. Like the other two Schools in DIAS, STP has no undergraduate teaching duties although it does provide many seminars for students and research staff from all Irish universities. At a time when Ireland is coping with very severe fiscal problems, the role of indigenous research in the physical sciences can hardly be overstated and STP's contribution is of fundamental and growing importance:

Through its research, it strengthens the prestige of Irish science in the world. This will allow the School to attract more top scientists to Ireland and to attract students from abroad to STP and Irish universities.

Through its own research and its outreach activities, it raises the profile of Mathematics and Physics in Irish society.

The School will help in the establishment of a Summer School Programme, with courses given by first rate physicists and mathematicians to students from Ireland and abroad.

STP will provide leadership for selected European research activities of strategic importance for Ireland.

1. Current Research Activities

The School pursues research in the general areas of theoretical physics and mathematics. Particular areas of expertise are: theoretical particle physics, quantum field theory, quantum gravity, quantum mechanics, quantum information theory, quantum and classical statistical mechanics, disordered systems, geometry and topology, noncommutative geometry and infinite-dimensional algebras, Lie groups and algebras, C*-algebras, functional analysis, and probability theory.

There are currently three research groups, headed by Professors Dorlas, Nahm and O'Connor.

"The School plays a very important role in focusing on curiosity-driven research in theoretical and mathematical physics in Ireland, defining and keeping up very high scientific standards..."

Specific research projects are as follows:

Quantum Information Theory

At present, information is transmitted (over the internet for example, or between banks) in digital form, that is, in the form of 'bits' which are expressed in terms of electrical signals in a 'high' or a 'low' state. However, there are proposals for more secure and efficient transmission in the form of 'quantum information', which is given by the quantum state of a stream of microscopic quantum systems, e.g. atoms or particles of light, called photons.

Theoretical research is carried out to investigate the optimal rate at which such quantum information can be transmitted such that it is robust against noise in the information channel.

Solvable models in Statistical Mechanics

In 1931 Hans Bethe introduced a new method for determining the energy spectrum of the one-dimensional Heisenberg model. The Heisenberg model was put forward by Heisenberg in 1925 as an explanation of the origin of ferromagnetism as a result of quantum effects. Bethe's method has since been shown to be applicable to many other models, all either one-dimensional quantum models or two-dimensional classical models. Several of these models are being studied by members of the School.

Bose-Einstein condensation

Bose-Einstein condensation is a phenomenon first suggested by Einstein in 1925 on theoretical grounds, as a consequence of a new form of statistics proposed by Bose. It is long known that particles with integral spin obey Bose statistics,

Prof. David Spearman, Prof. Cumrun Vafa, Prof. Werner Nahm, Prof. John Pethica and Prof. Jaffe at an event in honour of Prof. Nahm's election to the Fellowship of the Royal Society.

but it proved very difficult to observe Bose-Einstein condensation experimentally in its purest form, even though it is thought to play a role in the phenomena of superfluidity in liquid helium and in superconductivity. In 1995, Wieman and Cornell succeeded in observing Bose-Einstein condensation in atomic vapours at extremely low temperatures (nano Kelvins). In the meantime, the effect of interactions between the particles on this phenomenon is still poorly understood. It has been a subject of theoretical research in the Institute for many years.

Noncommutative geometry and field theory

One of the particular features of quantum mechanics is that observable quantities in general do not commute. That means that if one measures first quantity A and then quantity B of a microscopic system, the results will in general be different from those obtained if one first

measures B and then A. It was proposed by Connes in the 1980s that one can construct analogues of geometric notions like distance and curvature for spaces where such noncommuting objects play the role of 'points'. These new constructs are now being investigated in applications to quantum field theory, i.e. the theory of elementary particles. This gives rise to new approaches to computational approximations for calculating properties of these particles as well as proposals for new theories beyond the current Standard Model. In particular, it also gives rise to a new approach to quantum gravity. Both Monte Carlo calculations and theoretical studies are being pursued in the School.

Conformal field theory and integrable deformations

Conformal field theory is a theory of fields which are invariant not just under the usual space translations and rotations, but also under dilations. This high degree of symmetry allows many aspects of these theories to be calculated exactly, i.e. without approximations. They play an important role in understanding critical phenomena, especially in low dimensional systems, where many so-called critical exponents can be calculated and compared with experiment. They are also important for understanding certain aspects of string theory, the most promising theory of elementary particles incorporating Einstein's general theory of relativity. In STP, small deviations from conformal theories are being studied, which can nevertheless be solved and give insight into the breaking of conformal invariance.

Prof. Jaffe, Chairman of School of Theoretical Physics Governing Board and Prof. Shatashvili, Director of Hamilton Mathematics Institute TCD.

Edge states in the quantum Hall effect

The quantum Hall effect was discovered by Von Klitzing in 1980 in a very pure sample of semiconducting material at low temperatures and in a high magnetic field. He found that at low temperatures the conductivity in the transverse direction, first discovered by Hall in 1879, exhibits so-called plateaus as the strength of the field is varied. This can be explained in terms of currents flowing at the edges of the sample. Initially it was found that the Hall conductivity exhibited plateaus at integer multiples of a certain fundamental quantity, but more accurate experiments later showed that there are also plateaus at certain fractional values. Recently, a similar effect has been discovered in sheets of graphite, one atom thick, which can now be routinely manufactured with great precision. The explanation is somewhat different from the usual quantum Hall effect and relies on the specific electronic structure of graphite. Remarkably, this structure has a mathematical similarity with Dirac's theory of relativistic electrons, which makes mathematical techniques from this theory

applicable. Consequences for the presumed corresponding edge currents are now being researched.

Vanishing theorems

Original research is also taking place in more mathematical areas, notably the geometry of vector bundles. This concerns symmetries of such bundles which are similar in nature to symmetries found in Calabi-Yau varieties, which are geometric spaces of a particular kind.

2. Relation between Fundamental and Applied Research

Traditionally, DIAS has concentrated its research activities in fundamental or basic areas. Its overall thrust was to add to the sum of human knowledge for its own sake, by extending the frontiers of knowledge in its fields of expertise. It has placed less emphasis on the other broad category of research referred to as applied research. A notable exception to this policy is the research by the late Professor Lewis, who, amongst other issues, carried out research into applications of probability theory to communication networks. This led to the founding of a successful company, Corvil Networks. The success of the company illustrates the general principle that applied research relies for its raw material on the outcomes of fundamental research. On the other hand, insights gained in the course of application of principles formulated by original investigators can lead to a reassessment of those principles or the germ for new principles. It may be noted that the first function assigned to STP in the Act is: "the investigation of the mathematical principles of natural philosophy *and the application of those principles to the physical and chemical group of sciences and to geophysics and cosmology*". This suggests that the founders of the Institute already recognised the importance of fundamental research for applications. It should be recognised, however, that at the time the fundamental research is carried out, these applications are usually unforeseen.

To further emphasise the importance of fundamental principles in applications, it may be useful to give a few examples.

1. The first Director of STP, the famous Professor Schrödinger, discovered the *wave equation of quantum mechanics*. This equation is at the root of all of chemistry as well as much of physics. It is used on a daily basis by chemists to describe and predict the properties of new and existing materials. It is also the basis of electronics and led directly to the development of transistors.

2. Einstein's General Theory of Relativity was long considered of little practical value. This has now changed as a result of the development of the *Global Positioning System*, which would not be accurate enough if the effect of gravity on the clocks in the satellites used were not taken into account. The necessary corrections are computed using Einstein's theory.

3. Number Theory, the most abstruse area of Mathematics, was developed purely because of scientific curiosity. It has now found important applications in *cryptographic and error-correcting codes*, which are used to transmit information securely and error-free over the internet. Error-correcting codes are also used, for example, in mobile phones and CD and DVD players, as well as to transmit data over long distances in space.

4. The *World-Wide Web* was developed as a result of a need that arose in the European centre for particle physics (CERN) for particle physics researchers to communicate within this large organisation and to visualise the massive data bases used for analysing particle reactions.

5. While working on purely theoretical problems in Statistical Mechanics, an area of physics dealing with systems of many particles, Prof. Lewis noticed in 1992 an analogy with the *transmission of information*. Although this analogy was in fact well-known, it had not been noted that a particular method, common in Statistical Mechanics, could also be applied for the efficient transmission of information. The realisation of this idea led to the founding of a successful company.

3. Strategic Objectives

3.1 Appointment of new staff

In 2009 the research of the School was assessed by a panel of international experts. It recommended in particular that the School should be strengthened by the appointment of two or three Schrödinger Fellows. It is regretted that during the period covered by the previous plan the objective of appointing any new staff was not realised. For the period covered by this Strategic Plan it is likely that the School will lose some staff. The impact that this will have on the School is very serious and puts at risk the work that is currently carried out at the School. Whilst this is happening, research in the fields of Theoretical Physics and Mathematics is thriving internationally, and we argue that it would be of great benefit to the well-being of research in Ireland if the complement of senior staff in the School could be enlarged. Indeed, research in the School is internationally recognised for its quality, as is demonstrated by the large number of high-quality applicants to Scholarship and Fellowship positions, as well as by the constant stream of eminent international researchers visiting the School. Due in particular to its reputation the School has been able to attract a limited number of externally funded Fellows. The appointment of new senior staff would allow the School to expand into new promising areas of research, which are currently in rapid development.

The main purpose of appointing new senior staff should be to significantly increase the profile of the School. It is likely that an increase in the current staffing levels will only be possible by the influx of new funds into the School. Funding from the Irish Exchequer is being reduced at present. Therefore, it will be necessary for the School to either (a) successfully apply for grants from Programmes funded by the Irish Exchequer or EU or (b) that it receives donations from philanthropic sources. It must be pointed out that the areas of research regarded as priorities by the Irish Government are not immediately compatible with those of the School. In such circumstances it is difficult to see how the School will be able to benefit from any of the funding programmes that will be operated through the Irish Exchequer in the period covered by this Strategic Plan.

General Relativity and Cosmology

In earlier years, work in the School has contributed substantially to research into General Relativity. The General Theory of Relativity was of course formulated by Einstein in the period 1912-1918 and he worked out some of the consequences at the time, notably the perihelion shift of Mercury, the bending of light rays around the Sun and the existence of gravitational waves, but the theory is extremely rich and many other consequences were calculated by workers in the Institute. Unfortunately, some of this expertise has been

lost with the death of Professors Synge and Lanczos. General Relativity Theory has recently become of technological importance due to the development of the Global Positioning System, which would not be possible without taking account of the corrections needed to take account of general relativistic effects. It has also become of increased importance in Astronomy and Cosmology. Gravitational waves have still not been detected directly, but they have recently been detected indirectly in systems of double stars. Cosmology, the study of the evolution of the early Universe, has recently evolved into a true observational science with the precise measurement of the cosmic microwave background radiation and the accurate determination of the Hubble constant using supernovas as standard candles for distance measurement. This has led to new theoretical puzzles and models.

There have been remarkable recent developments in Cosmology. Since Einstein proposed his general theory of relativity various people have constructed models of the Universe compatible with the Einstein equations. Observational work by Hubble then indicated that the most feasible models were those in which the Universe has expanded from an initially much smaller size. This is called the Big Bang model. This model still has a number of undetermined parameters like the total amount of matter in the Universe, etc. Recent very accurate observations have narrowed down the possible values of these parameters, and it has, in particular, become clear that ordinary matter constitutes only about 30% of the total amount of mass present. The remaining mass is called dark matter, the nature of which is currently very unclear. It is an intriguing problem, but the Institute has at the moment no researchers pursuing or specialising in this area.

Prof. Dr. Hermann Nicolai, Director of Max Planck Institute for Gravitational Physics, Prof. Samson Shatashvili, Director of Hamilton Mathematics Institute TCD and Prof. Ludvig Faddeev, Director of Euler Institute, St Petersburg at a conference in honour of Prof. Nahm, Director of School of Theoretical Physics.

Quantum computation and quantum information

Another rapidly developing area is that of quantum computation and quantum information. This may indeed have important technological implications in the future. It is critical for Ireland to be involved in this development. Quantum computation is a general term for the proposal to harness the quantum nature of matter to construct a new generation of computers which are much faster and efficient for certain tasks. STP would be a particularly suitable place to be involved in this venture, but there is at the moment no researcher in the School for whom this is the main interest. However, the School appointed a Schrödinger Fellow with an interest in this area. He was offered a permanent position in one of the Universities but collaboration with him in the subject area continues.

A related area is that of quantum information theory. This is the theory of the information that quantum computers manipulate and how this is transported over communication lines, inside a quantum computer as well as over longer distances. The latter is in fact closer to practical realisation, and will, in particular, have serious implications for the transmission of confidential information.

Condensed Matter Theory/Quantum Hall Effect

Another important development in Condensed Matter Theory was the discovery of the Quantum Hall Effect by Von Klitzing in 1982 and the related Fractional Quantum Hall Effect by Tsui and Stormer in 1998. The integer effect has important technical applications in the accurate measurement of resistance in particular, as well as for the determination of fundamental constants. Its theoretical basis is now well-understood however. The fractional effect is much more delicate and can only be observed in extremely clean semiconductors and at extremely low temperatures. Also it is theoretically far less well-understood. The existing theory of this effect has striking links with topological quantum field theory. There is some expertise in the School already in this area, especially in relation to a similar phenomenon which has recently been observed in graphene, an atomic layer of carbon. There are also possible applications to quantum computing.

Other fundamental questions in Condensed Matter Physics are, for example, the derivation of non-equilibrium behaviour and the first-principles calculation of properties of materials.

Prof. Sinéad Ryan, School of Mathematics TCD, Prof. Michael Tuite, School of Mathematics NUIG, Prof. David Spearman, past president of Royal Irish Academy and Dr. S. Kovacs, Fellow of School of Theoretical Physics at a conference in honour of Prof. Werner Nahm.

String Theory

String theory has been, and still is the most prominent theory for extending the existing Standard Model of particle physics and unifying it with Einstein's theory of gravity. Although it has so far not led to experimentally verifiable predictions, this may change in the near future with the completion of the Large Hadron Collider in CERN. In the meantime, it has led to important developments in pure mathematics, resulting in a number of conjectures which have since been proved by other means, and in the formulation of new natural structures and unexpected relationships between originally quite distinct areas of mathematics.

Number Theory and Algebraic Geometry

Perhaps the most famous problem in mathematics is Fermat's Last Theorem, which states that there are no integer numbers x, y and z which are solutions to the equation $x^n + y^n = z^n$ for any $n>2$. It has recently been proved by Andrew Wiles. His solution has given rise to many new developments in mathematics and much work is currently done in this area, which is also of importance for coding theory. His proof was based on connections with algebraic geometry, which, as a result, is also in rapid flux.

3.3 Involvement with Graduate Schools and organisation of Summer Schools in Ireland

We support the initiative of IRCSET to start up Graduate Schools in the physical sciences in Ireland and envisage contributing to it in a constructive way. We believe that we are particularly well-placed for this purpose because we do not have any formal undergraduate teaching duties and we have extensive international contacts and a regular visitor programme. It should be borne in mind that the number of graduate students in Mathematics and Physics in the Dublin area is limited. This means that in order that graduate courses are worthwhile it is essential that they are pitched at the right level, which on the one hand is specific enough to provide a useful addition to the knowledge base for beginning graduate students, but on the other hand, is broad enough that the number of attendants does not fall below a reasonable minimum of about five students. The Science Schools, and STP in particular, have the advantage that its staff is both highly qualified and free from undergraduate teaching duties which might be compromised by the graduate teaching effort. (In some cases, staff members do give undergraduate courses at present, but those would generally also be suitable for graduate students, or could easily be adapted for that purpose.) Moreover, we already have many international visitors, some of whom could be asked to give graduate courses as part of the Graduate School programme. Obviously, this will need additional funding.

In view of the limited number of prospective graduate students, we propose that a better way to start off a graduate teaching programme might be to organise international Summer Schools. In our experience these are particularly effective ways to introduce graduate students to the latest developments in a field. They have the advantage that they are very intensive but of relatively short duration so that the School does not take up too much of a graduate student's time needed for their individual projects. Moreover, Summer Schools do not require large numbers of students, because students from abroad would also be invited to participate. Lectures are given by selected international experts in a given area. Thus, Summer Schools have the added advantage that students also come into contact with other researchers in the same area at an early stage of their career. We propose that the two Science Schools could organise a Summer School in alternate years if appropriate funds are provided. We propose to include in the programme of such Summer Schools an industrial element in the form of a presentation and/or reception with representatives from industry, in particular the industrial research community, to make the students aware of the opportunities in this direction. A meeting with representatives from the main universities could also be included to highlight job opportunities there.

3.4 Increased visitor funds

In line with other comparable research institutes, an increase in funds for visitors would be very advantageous for the working environment of the School. We propose additional funds for inviting at least one long-term visitor per year. This could be in the form of an agreement with the Irish universities whereby the School would pay an agreed share of the salary of a Professor on sabbatical who spends six months or a year at the Institute.

3.5 New Building

The School supports the Institute's strategy of moving to a suitable building where the three Schools and administration would be co-located.

3.6 Links with other research institutes

We aim to form stronger and more formal links with similar research institutes in Ireland and abroad, particularly in our areas of expertise. This will help to bolster our position as an important player in the international network of fundamental research institutes. It should also improve our chances of obtaining European grants and attracting the best postdoctoral researchers.

3.7 New plan for Mathematics funding

The present climate for research in Ireland is less favourable than it has ever been. New funding initiatives are very limited. We feel that the current SFI funding initiatives put too much emphasis on collaboration with industry, which is inappropriate for fostering high-quality research. We intend to formulate a plan for advanced mathematics research funding ourselves, incorporating a number of proposals, notably funding for:

- International Conferences
- Summer Schools
- Long-term visitors
- Sabbaticals for Irish researchers

3.8 Improved public profile

Another goal the School will pursue is to improve its public profile. Some progress has already been made in this regard, but more needs to be done. The speakers giving the Statutory Public Lectures have been chosen for their ability to deliver talks suitable for a general audience and they have on the whole been very successful in that regard. More effort will be devoted to this. We will try to give more visible public notice of these events and attract high-profile speakers.

"The School has also become an emerging world leader in electromagnetic geophysics, seismology, marine geophysics and geodynamics."

School of Cosmic Physics – Strategy Statement

Our Vision is to take Physics out of the laboratory and apply it to the World and the Universe.

Our Mission is to be the focus of Cosmic Physics research in Ireland and the hub enabling its Irish researchers and students to participate in, and contribute to, global networks of research excellence and resources.

Background, History and Mission

SCP is the youngest of the three Schools that currently constitute DIAS. Formed in 1947, it is mandated by its establishment order to undertake theoretical, computational and observational studies of physics related to understanding the Cosmos in which we live, from the Earth's core to the outer reaches of the Universe, including, but not limited to, astronomy and astrophysics, astroparticle physics, geophysics, meteorology and oceanography.

Currently functionally structured into two divisions, one focussed on the interior of the Earth (the Geophysics section) and the other focussed outwards (the combined Astronomy and Astrophysics sections), the School leads national activity in these areas and is known internationally for the depth, breadth and quality of its activities.

Independent review panels in 2004 and 2009 comprising distinguished international scientists gave glowing assessments of the School. Sample quotes include:

- "the Review Panel has a high regard for the research activities of the DIAS School of Cosmic Physics" [Green Report, 2004; de Graauw Report, 2009]
- "DIAS researchers remain the most influential group of astrophysicists and astronomers in the country " [Green Report, 2004; de Graauw Report, 2009]
- "the School has also become an emerging world leader in electromagnetic geophysics, seismology, marine geophysics and geodynamics" [de Graauw Report, 2009]
- "DIAS is well positioned to initiate and lead national-scale collaborations" [de Graauw Report, 2009]

A mark of the excellence of the senior academic staff, and the esteem in which they are held in Ireland, four of the five Professors and Senior Professors in the School are members of the Royal Irish Academy. In addition, one Senior Professor (Drury) is currently the President of the RIA, a Professor (Ray) is on Council, and the other Senior Professor (Jones) is on the Geosciences Committee.

APPENDIX 1 PROGRAMME OF SCHOOL ACTIVITIES (CONTINUED)

The School's productivity is exceptional compared to national[1] and international peers. Over 110 papers were published in the international peer-reviewed literature in 2011 with at least one school member listed as an author. School members are Editors, or on the Editorial Board, of several first-rank journals. Citation rates for School members are well in excess of national averages, with the two Senior Professors having rates of 32 citations/paper (Jones) and 46 citations/paper (Drury). One very commonly used, though crude, bibliometric is the h-index introduced by Hirsch[2]. Jones and Drury's h-indices are 38 and 48 respectively; very high by international standards. The highest h-index in the Institute, and probably in the country, is that of Astronomy Professor F. Aharonian which currently stands at 70.

The School has led and contributed, and continues to contribute, to national priorities and agendas. Notably:

- Work by the Geophysics Section in the 1980s led directly to arguments Ireland is using for its claim under the Law of the Sea to economic exploitation rights over an area ten times its exposed landmass.
- Work in the former Cosmic Ray Section, first with NASA on the Apollo missions in the 1960s and subsequently with the European Space Agency ESA, initiated space research in Ireland.
- The Senior Professor of Geophysics during the 1980s and 1990s, Brian Jacob, was a member of the Pugwash Conferences on Science and World Affairs that was awarded the Nobel Peace Prize in 1995 "for their efforts to diminish the part played by nuclear arms in international politics and, in the longer run, to eliminate such arms..."
- The Geophysics Section is the National Data Centre for the Comprehensive Nuclear Test Ban Treaty Organisation (CTBTO), and staff is being trained to be on-site inspectors.
- The Astrophysics Section, through PRTLI grants, engendered in 2005 the formation of the Irish Centre for High-End Computing (ICHEC, www.ichec.ie) through which Irish academics have access to world-class computing capabilities.
- The Geophysics Section houses the All-Ireland Irish Geoscience Graduate Programme (IGGP, www.iggp.ie) on behalf of all Irish academic institutions. The IGGP is a virtual graduate training school in the geosciences.
- The Geophysics Section is currently leading national efforts to determine Ireland's potential for electric power and district heating generation through geothermal energy under the IRETHERM project (www.iretherm.ie).
- A member of the Astrophysics section, Professor Tom Ray, at the invitation of the Director of the European Southern Observatory (ESO http://www.eso.org), is the new Chairman of the ESO Observing Programme Committee with specific responsibility for the Interstellar Medium, Star Formation and Planetary Systems. This is all the more remarkable in that Ireland is not a member state of ESO.

1 Profile of Public Research Activity in Ireland 1998-2006, Forfás/HEA report, published December 2010.
2 A scientist with an index of *h* has published *h* papers each of which has been cited in other papers at least *h* times. A value over 30 in physics would normally be regarded as indicating an internationally recognised discipline leader.

The School has a number of high profile outreach activities for the general public and also for the 1st and 2nd Levels in Irish schools. The most well-known, and also a statutory obligation, is the provision of a public lecture once per year. Apart from that, the two with the greatest public engagement are the long-established and popular public open nights held in Dunsink Observatory on the first and third Wednesday of each month during the winter, and the new (since 2008) Seismology in Schools programme with teaching seismometers in over 60 schools as well as in GeoParks, including the Cliffs of Moher, and University departments. One impact of the latter is that the Department of Education and Skills is considering modifying the Physics Leaving Certificate curriculum to include a module on seismology, thus addressing the national crisis of students exhibiting decreasing interest in the sciences and mathematics.

The School members have extensive collaborations, both national and international, with academia, government and industry. These collaborations allow members to leverage resources far in excess of those available within the School, or indeed within Ireland. The two best examples in Astronomy and Astrophysics are perhaps the participation in the HESS collaboration (winner of the EU Descartes prize for collaborative European research, the Rossi prize of the American Astronomical Association, and judged to be one of the ten highest-impact astronomical facilities of the past decade[3]) and in the MIRI collaboration to build one of the main instruments for the next great space observatory, the James Webb space telescope, which will secure access by the star formation group to data of unprecedented resolution in the coming decade. In Geophysics, the SAMTEX Consortium built and organised by Jones has resulted in over €2 million worth of MT data for an outlay by Irish sources of less than $200,000, and ongoing collaborations of Section seismologists with scientists on both sides of the North Atlantic is yielding access to data worth many millions of euro.

Prof. Tom Ray, School of Cosmic Physics, participating in Venus Transit, Skerries.

3 Madrid, J. P. and Macchetto, D. arXiv:0901.4552

Students attending the first summer school in High Energy Astrophysics organised by Prof. Felix Aharonian.

The School suffers somewhat from being dispersed across three physical locations and being housed in old buildings that are not ideal for modern scientific research. While this is more a matter for the overall Institutional strategy, the School wishes to place on record its support for colocation of the research work of the Institute in an appropriate centrally-located single building with convenient access to the local universities and public transport. At the same time, the School is conscious of its responsibility towards the historic Dunsink Observatory and plans to develop this as a residential, outreach and off-site meeting facility available to the broader academic community.

Strategic Framework

The work of the school can be divided into four broad pillars that together support the school and form the structure around which this strategic plan is organised (see table at the end of this section).

(a) The first of these, and the most important, is advanced research in specialist areas of Cosmic Physics. This is the fundamental raison d'être of any school in an Institute for Advanced Studies. The School enjoys a high international reputation among its peers and the most important high level objective is to retain and to enhance this.

(b) The second is the contribution that the School makes to the quality and standing of the Irish educational system through the training it provides to Irish and international fourth-level and fifth-level students and postdocs in methods of advanced research. PhD students registered in almost all the Irish universities, and some foreign ones, have been and are co-supervised by the academic staff of the school. In addition the School has put in place framework agreements on collaboration with most of the local universities which allow participation by the School's research staff in the life of the local third-level institutions and vice versa. Agreements exist with international institutions that enable Irish science to be projected across the globe. The School has also been a significant source of candidates for recruitment by Irish third-level institutions with former members of the School now occupying positions in six of the seven Irish universities as well as the Dublin Institute of Technology.

(c) Thirdly, the school has a role in promoting, developing and supporting, research infrastructures at national and international level. Advanced research in Cosmic Physics requires, in almost all cases, access to advanced observational facilities and e-infrastructures. This implies that the School has to act as discipline leader and national coordinator where appropriate.

(d) Fourthly, and finally, the School has a duty to communicate its work to civic society and the general public through various outreach activities and programmes. The prominence given to the statutory public lectures in the establishment order is an indication of the importance attached to this aspect of the School's work, even back in 1947. What could not have been anticipated was the urgency that would attach to having an informed debate in civic society about such issues as climate change and energy resources where authoritative evidence-based input from Cosmic Physics is relevant. In addition, Cosmic Physics has an important role to play as an accessible and attractive introduction to the 'hard' sciences.

It is important to set outcome and impact targets, and to establish verification measures, in each area. As far as international research quality and reputation is concerned, the quinquennial external reviews (the next one is due in 2014) have proven a remarkably successful, albeit exacting, tool in validating the research work and benchmarking it against global standards while at the same time defending research autonomy. The reviews consider all aspects of the School's work, but it is clear that they speak with most authority when they comment on the international research standing of the School. In this plan we therefore consider the issue of whether similar instruments can be developed for the other pillars. Such instruments, allied to achievable objectives in these areas, would greatly strengthen the school's position. The following table attempts to summarise this.

APPENDIX 1 PROGRAMME OF SCHOOL ACTIVITIES (CONTINUED)

	Pillar 1	Pillar 2	Pillar 3	Pillar 4
High-Level Objectives	International reputation for pioneering and excellent research	Enhancement of the national education and research systems	Infrastructural contributions and leadership at national level	Public outreach and involvement with government and civic society
Implementation Plans	Research Strategy	Training and Cooperation Strategy	Infrastructure and Leadership Strategy	Outreach and Communication Strategy
Outputs	Publications, presentations, research consortia	PhD students, research associateships, partnerships	Shared services for the research community	Engagement with public through lectures and open nights. Engagement with young minds through outreach programmes in schools
Outcomes	International recognition, impact and influence	Institutional recognition by national bodies	National profile among the public and academic communities. Leadership of national activities	Public knowledge of the School's work, increased interest in Cosmic Physics, evidence-based contributions to public debates (e.g. climate change, resource exploitation, sustainable energy options, etc.)
Verification Instruments	International peer review, awards, bibliometrics	Review by partner institutions, feedback from students and associates	User surveys and reviews	Media coverage, public feedback, enhanced exploration activity, Government policy decisions

Research strategy

Of the vast range of possible areas that Cosmic Physics encompasses, the school currently has strong research programmes in two broad areas, Geophysics and Astrophysics (including Astronomy and Astroparticle Physics).

The Geophysics Section has developed strengths and interests in crustal, lithospheric and upper mantle scale studies both locally and internationally. Projects with DIAS staff actively undertaking field measurements are ongoing in Ireland; the Netherlands; southern, central and northern Africa; Canada; Scandinavia and China. In addition, the Section is adding research activities related to Irish societal needs. IRETHERM[4] is bringing together academic, government and industry geoscientists from across the whole of Ireland in a co-ordinated project to assess the geothermal energy potential of the island. The Irish National Seismic Network[5] and the Ireland Array project[6] together provide valuable information to the State on the local natural seismicity and seismic hazard levels, as well as providing the international community with high quality seismic recordings from distant earthquakes. Studies are being started on carbon dioxide storage options and the monitoring of carbon dioxide sequestration.

A fundamental issue in Astronomy remains the process of star formation. Stars once formed are well understood, but the processes whereby clouds of interstellar dust and gas condense into clumps and eventually give rise to stars are still uncertain in many areas. This is an area where the School has made significant contributions, including the first detection of outflows from forming brown dwarfs and direct evidence for jet rotation in some proto-stellar outflows. The research is driven observationally by the ever-increasing spatial resolution available with modern facilities such as the Hubble Space Telescope and on the theoretical side by the increasing sophistication of numerical models and simulations. Another hot Astronomical topic is the high-energy non-thermal emission observed from many astrophysical systems. Extremely high-energy particles, often with ultra-relativistic energies, are either seen directly (as in the cosmic rays) or inferred to exist through their emission signatures in systems as diverse as active galactic nuclei, pulsars and supernova remnants. Understanding the phenomenology and the fundamental physics of such sources forms an important part of the emerging discipline of Astroparticle Physics, another key strength of the School building on its earlier work in cosmic ray physics. A key factor here has been participation in the European HESS consortium which has opened up a new observational window on the universe by enabling astronomy with TeV energy gamma-rays.

These are all topical areas of current research and it is neither appropriate nor practical to change them significantly at this time. It is, however, prudent to ask the question of whether there are emerging areas in which the section should invest with a view to having an orderly succession planning when the current research leaders retire, and it is strongly recommended that the Board discuss this issue before the next quinquennial review and seek the expert advice of the review panel on the options available. There is a good argument for reverting to having at least three

4 www.iretherm.ie
5 http://www.dias.ie/index.php option=com_content&view=article&id=4018&Itemid=256&lang=en
6 http://www.dias.ie/ireland_array/

independent research areas represented in the school, although this does of course have resource implications.

Research is carried out in many different organisations, ranging from industrial R&D units to university departments to specialist research centres. An Institute for Advanced Studies, and more specifically a School of Cosmic Physics, to live up to its name and fulfil its mission must support a range of individuals working at the edges of their disciplines and interacting globally. The School does this by defining itself as an open and outward-facing organisation supporting a complex network of partnerships. Internationally, it is the Irish node in multiple global networks of research excellence and resources. Nationally, it is the trusted and valued research partner of local third-level and research institutes.

This concept has a number of advantages. Firstly, by leveraging resources of network partners it manages to do a great deal with limited local resources and avoids to some extent the issue of "critical mass". Secondly it is highly scalable, flexible and capable of supporting multiple projects and disciplines. Thirdly it provides the School with a mission that is unique in Ireland, and one which clearly differentiates it from, and positions it as a complementary partner to, the rest of the third-level and research sector. It is tempting to borrow an analogy from cloud computing. Instead of investing in expensive static local resources, the cloud model of computing dynamically accesses resources located on external networks as required. If the conventional static solution is the traditional research institute, this vision is closer to the cloud model.

The School has had considerable success in attracting significant research funding from both national (PRTLI, SFI, IRCSET), European (FP7, Marie Curie fellowships, ESF) and (in Geophysics) commercial sources. It is clear that the possibilities at national level are now considerably reduced and effort will have to be focussed on developing non-exchequer funding sources with a renewed emphasis on EU funding. It is helpful that the new European Research Council, with its exclusive emphasis on research excellence, is well aligned with the mission of DIAS and the School (and indeed the whole of DIAS) should make a determined effort to get ERC funding

The value of the Schrödinger fellowship scheme (five year fellowships for promising candidates near the start of their academic careers) in attracting active young researchers to DIAS has been amply demonstrated and it is highly regrettable that these important and flexible positions, which it should be noted were created by the conversion of permanent positions at assistant professor and research assistant level, are now threatened by the employment control framework. There is a very strong case for increasing the number of fellowships available as was advocated by the last external review. The number of PhD scholarship positions should also be increased in proportion to allow the Schrödinger Fellows to supervise PhD students.

The key priority for Astronomy and Astrophysics in the short term is to fill the currently vacant Senior Professorship. The Section is already well embedded in a number of international and national networks in the areas of star formation, high-energy astrophysics and astro-particle-physics. In Star Formation the School's strong position in

the Mid-Infrared Instrument (MIRI) consortium and the James Webb Space Telescope (JWST) provides a clear focus for work in this area over the next several years, but it would be highly desirable to complement this with cutting-edge infrared detector development in collaboration with Irish and international partners.

In high-energy astrophysics the recent decision to establish a Centre for AstroParticle Physics and Astrophysics provides a welcome recognition of the leadership role that the Section plays in this rapidly developing field with a strong emphasis on theoretical and phenomenological aspects. A key strategic imperative is to build up this centre as the recognised Dublin nexus for work in this area, ideally with new fellowship and student positions.

The key aims of the School's research are thus:

- To understand the process of star formation and its associated phenomena.
- To understand the response of the lithosphere to dynamical forcing.
- To understand the non-thermal particle acceleration and radiation processes that dominate many astrophysical systems.
- To understand the formation and evolution of cratons.

The key objectives in fulfilling these aims are:

- Fill the currently vacant senior professorship in Astronomy.
- Increase the number of Schrödinger fellows, ideally to at least two per senior professor and one per professor.

Tánaiste Eamonn Gilmore T.D. at the launch of CTBTO.

- Increase the number of PhD scholarship positions to at least one per permanent academic and Schrödinger fellow.
- Initiate a succession planning exercise for the School.
- Consolidate the Centre for AstroParticle Physics and Astrophysics to maintain and enhance the School's internationally recognised leading position in theory and phenomenology of high energy astrophysics and astroparticle physics.
- Consolidate activities in lithospheric geophysics into a new Irish Centre for Lithospheric Studies which would be the leading centre in Ireland.
- Maintain and enhance the School's position and role in large-scale multi-national projects.

- Maintain and enhance the School's central position and role in national geoscience, astronomy, astrophysics and space-related activities.
- Leverage the MIRI project for additional posts to work in new infrared/millimetre detector technology (in particular kinetic inductance detectors or KIDs).
- Attract non-exchequer funding.

Outputs and outcomes

The primary output from research is publications, and presentations of work at conferences and meetings. The desired outcome is impact on the field. Proxies for impact are citation rates, invitations to conference, awards and distinctions, invitations to act as an expert reviewer etc.

Targets for the School are:

- To maintain the current level of scientific productivity in as much as resources allow.
- To maintain and seek to increase the impact of the School's research work.
- To increase the amount of non-exchequer grant income raised by the School.

Verification measures

The Governing Board reviews the research output regularly and this is reported on in the annual research reports.

External research funding applications and success rates are regularly evaluated by the Governing Board.

The primary mechanism for validating the quality of the research is the quinquennial external review by our international peers.

Impact proxies will be regularly monitored by the Governing Board.

Training and Cooperation Strategy

The aim of this part of the Strategic plan is to enhance the School's contributions to the teaching and research of our third-level partner institutions. Whereas the research strategy is directed in large part at the international research community, and aims at international peer recognition, this part aims at national institutional recognition. The current climate at third-level, where shared services are actively encouraged and every effort is being made to avoid unnecessary duplication of resources, offers a good opportunity for the School to take the lead in organising and coordinating regional or national teaching consortia following the very successful example of the Irish Geoscience Graduate Programme – IGGP (www.iggp.ie).[7]

The Astronomy and Astrophysics Sections have signed framework agreements on cooperation with the Physics Departments in TCD and UCD, and the Institute has signed a letter of intent on

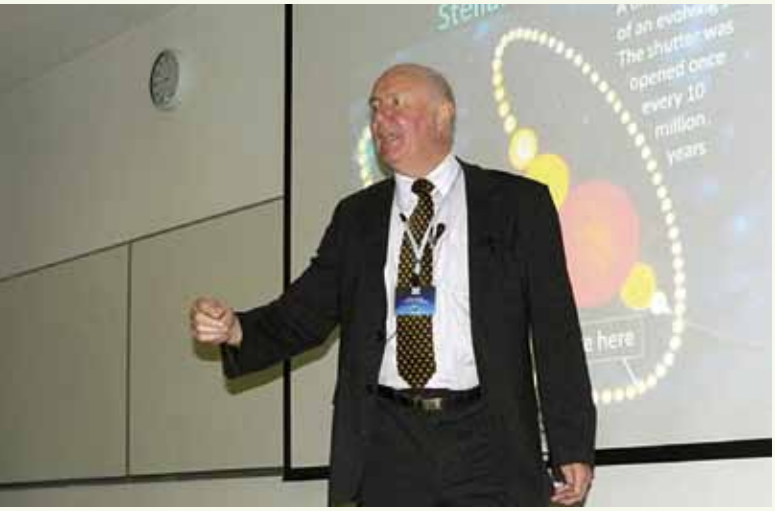
7 This is funded under a Griffith Award of the Department of Communications, Energy and Natural Resources (http://www.gsi.ie/Geoscience+Initiatives/Griffith+Geoscience+Research+Awards.htm) to Senior Professor Alan Jones. The programme's visionary and unique objective has established a robust holistic broad based training programme for postgraduate students, wherever they are registered for their fourth-level degrees (primarily PhD) on the island of Ireland.

cooperation with DCU. These agreements formalise long-standing patterns of cooperation which in the past were mostly organised on a personal level or as ad hoc arrangements. The role of Astronomy in attracting students into the study of the physical sciences is now universally recognised and all Irish universities now offer some instruction in Astronomy and employ at least one astrophysicist or astronomer on their teaching staff. None, however, can offer the breadth of coverage needed for a really good modern programme, especially at graduate level, and this is a golden opportunity for the School to emulate the success of the Geophysics section (albeit without the support of a Griffith grant).

The need for trained geophysicists has never been greater. The discipline of geophysics is no longer confined primarily to the extraction industries, but also now includes societal issues from the global, like climate change, to the local, such as access to clean water, sustainable energy provision, waste contamination monitoring, etc. There is a global scarcity in geophysicists, and that scarcity will be acutely exacerbated over the next decade. Locally, there is an increased demand for trained geophysicists within Ireland, not only to service the expanding exploration industries for Ireland's minerals, oil, and gas, but also groundwater, environmental, offshore and tourism developments. However, there is no growth of the discipline to deal with this explosive need. In addition, over half of the geophysics professionals in Ireland will retire within the current decade. These two trends are not unique to Ireland and have been recognised globally, particularly in the US. If the demand for trained geophysicists is not addressed internally within Ireland, either the posts will be filled from outside, or worse, will not be filled at all, and Ireland will either lose out on exploration activity and attendant income or will not have the basic geoscience infrastructure knowledge it needs to make logical and sensible decisions regarding societal developments that utilises geophysics knowledge.

Strategic aims:

- To further develop the arrangements for joint funding and supervision of PhD students and early-stage postdoctoral fellows, and to enhance the quality of PhD training in Cosmic Physics both in the School and in our partner Institutions.
- To organise graduate schools.
- To ensure that all active researchers working in Ireland who could benefit from cooperation with the Section are aware of our work and have been offered appropriate partnerships.
- To provide advice and assistance to partner third-level institutions in the delivery of specialist courses.
- To develop partnerships with other organisations at national level, e.g. state agencies and government departments, where there is mutual benefit.
- To draw on complementary expertise in our institutional partners, for example in the areas of technology transfer and public relations, to enhance the reputation of the School.
- To document the contribution of the School to the recruitment of quality staff by Irish institutions through an annual event to which they can all be invited.
- Maintain, grow, enhance and firmly establish the Irish Geoscience Graduate Programme and initiate a similar programme in Astrophysics.



Prof. Malcolm Longair, Emeritus Jacksonian Professor of Natural Philosophy, Cavendish Laboratory, Cambridge University, giving the Cosmic Physics Statutory Public Lecture 2011.

- Continue with the very effective Short Courses provided to the Irish geoscience community and consider similar initiatives in Astrophysics and Astronomy.

Outputs and Outcomes

Cooperation framework agreements are now in place with all three local universities. These will be developed and enhanced through regular meetings.

The School will hold at least two short courses or summer schools per year in cooperation with local third-level institutions.

All academic staff will be encouraged to do some level of guest lecturing at advanced level in Irish third-level institutions (subject to Board approval).

The School will, in partnership with local third-level institutions, develop, lead and participate in structured PhD programmes around its areas of expertise.

The School will encourage its fellows and students to apply for academic positions in local third-level institutions.

Verification Measures

The Board will review the minutes of the regular coordination meetings with third-level partners.

The views of partner institutions on the School will be sought in confidence on an occasional basis by the Board.

External teaching work is already monitored for conformance with institute policy and reported to the Governing Board; this will be extended to assess the nature and value of the contributions.

The School will monitor the destinations of departing scholars and fellows and maintain an alumni database.

Infrastructure and Leadership Strategy

The school has a long history of providing research infrastructures and discipline leadership in Cosmic Physics. It carried out the first magnetic and gravity surveys of Ireland and installed the first seismic network. It operated international observing facilities for optical astronomy on behalf of Irish astronomers through the Armagh-Dunsink-Harvard telescope and then the La Palma agreement. More recently it has become

the National Data Centre (NDC) for Ireland's contributions to the Comprehensive Nuclear Test Ban Treaty Organisation (CTBTO), helped establish the Irish Centre for High-End Computing, led the National Capability Computing Initiative and put in place the foundations for a national federated data service and a user-controlled light path network to facilitate very high-volume data transfers. A very substantial upgrade of the national seismic network has recently been completed, bringing the Irish National Seismic Network to modern standards.

The previous strategic plan called for the School to lead a campaign for Irish membership of the European Southern Observatory (ESO). For various reasons this did not happen and it is clear that there is little possibility of Ireland joining just at the moment, at least not for purely scientific reasons (despite this, as noted earlier, T. Ray has been appointed to chair a major committee of ESO and Irish astronomers have made use of ESO facilities). Almost the only form of observational astronomy that could be carried out from Ireland is radio astronomy and a very interesting recent suggestion is that Ireland could host one node of the LOFAR low-frequency radio array. This would be of considerable interest and is probably a more realistic short-term objective than membership of ESO (and the two are not necessarily exclusive). One node of LOFAR costs about €1.5 million with running costs (over five years) of about the same again.

The School's high-energy astrophysics group is involved in two ESFRI projects, CTA and KM3NeT as in-house theorists to the experiments (this is actually a good illustration of the research strategy of being the Dublin node in networks of excellence). It is also involved in the Japanese X-ray mission Astro-H.

Strategic aims:

- To continue to have key participant status in major international infrastructures relevant to our research, in particular HESS, ASTRO-H and the ESFRI projects KM3NeT, CTA and EPOS.
- To continue to have participant status in major international field campaigns relevant to our geophysics research.
- To push for an Irish LOFAR station
- To continue to push for an integrated Irish e-Infrastructure with particular emphasis on the needs of data-driven e-science.
- To provide community leadership and critically examine the case for ESO membership.
- To strengthen the links to ESA
- To maintain and strengthen the Irish National Seismic Network and the CTBTO National Data Centre.

Outputs and Outcomes

- Number of international infrastructure projects in which the School is involved.
- Number of national infrastructure projects in which the School is involved.
- Quality and coverage of the research infrastructures available to Irish researchers in cosmic physics.

Verification Measures

- Quinquennial review.
- Board oversight.

Public Outreach Strategy

The need for a well-informed civic society capable of rationally debating issues such as climate change, the environmental impact of mineral extraction technologies, the likelihood of asteroid impact etc. has never been greater and all of these examples are of course informed by Cosmic Physics. In addition, there is a clear need to increase interest in science generally and here Cosmic Physics has the great advantage of universal accessibility. Almost everyone is interested in the stars and planets as well as earthquakes and volcanoes. There is a long tradition of open nights at Dunsink Observatory which goes back to well before its transfer to DIAS in 1954.

The Training Strategy of the Geophysics Section is holistic and multi-faceted, ranging from activities aimed at schoolchildren to activities aimed at postgraduates. One tenet of this strategy is to deal with the fundamental problem facing Ireland of decreasing interest in the numerate sciences exhibited by Irish schoolchildren at both first and second level. A very successful school-based outreach programme, Seismology in Schools/ Seismeolaíocht sa Scoil Project (http://www.dias.ie/sis/) now has seismometers in 55 primary and secondary schools in the programme and has been extended to include colleges, universities and geo-parks. Using the seismometer and associated software distributed in this programme, students are able to record and study earthquakes from the other side of the world in real-time. Students monitor the performance of the seismometer daily and consolidate the learning and data collection techniques outlined in the training days. Ultimately students upload the recorded earthquake data to the International Schools in Seismology website to share their earthquake data with other schools initially in Ireland, the UK and USA. The experience of the Seismology in Schools pilot programme reinforces the idea that when science is relevant, learners become more engaged when they see how science is reflected in the reality of their own lives and by what they read in the media.

Strategic aims:

- To develop public outreach in astronomy at Dunsink Observatory and elsewhere and put it on a more professional footing.
- To maintain and enhance the Seismology in Schools programme with installation of seismometers in most of Ireland's second-level schools.
- To build on the success of the Seismology in Schools programme with follow-on projects for schools.
- To develop programmes in the public understanding of science and interact more with civic society through debates and discussions.
- To become a recognised source for authoritative media comment on issues related to Cosmic Physics.
- To facilitate the training of Irish science teachers in astronomy and geophysics as a vehicle for enthusing an interest in science amongst primary and secondary pupils.
- To provide expert advice to civic society on important societal issues, such as climate change, geothermal energy, carbon sequestration, fracking, etc.

Outputs and Outcomes

- Number of participants in various events, number of seismometers installed as part of the Seismology in Schools programme.
- Public interest in and knowledge of cosmic physics.
- Media coverage of the work of the School.
- Requests for commentary, expert analysis and advice from civic society.

Verification Measures

- The Institute needs to collect data on media references to DIAS and review these regularly.
- There should be regular surveys of participants in public events to get feedback.
- The use and impact of the Seismology in Schools equipment will be periodically reviewed.
- Visitor numbers and satisfaction at Dunsink will be monitored on a regular basis.
- Requests for expert advice and commentary will be monitored and recorded.

List of Abbreviations and Acronyms

CTA – Cherenkov Telescope Array, a proposed next generation instrument building on the success of the HESS experiment and one project on the current ESFRI roadmap. DIAS is a member.

ESA – the European Space Agency of which Ireland is a member.

ESFRI – European Strategic Forum for Research Infrastructures, a body charged with producing a coherent roadmap for the development of European research infrastructures.

ESO – the European Southern Observatory of which Ireland is not a member.

EPOS – Earth Plate Observation System, an ESFRI project to observe European tectonics.

HESS – the High-Energy Stereoscopic System, a European project to operate a system of imaging atmospheric Cherenkov telescopes in Namibia. DIAS is a member.

KM3NeT – an ESFRI project to construct a cubic kilometre neutrino telescope in the Mediterranean sea. DIAS is a member.

LOFAR – a European radio astronomy project aimed at developing low frequency radio astronomy http://www.lofar.org. DIAS has supported the iLOFAR project to get one base station installed in Birr.

MIRI – the Mid Infra-Red Instrument, a key European contribution to the James Webb Space telescope. DIAS is a member.

APPENDIX 2
SUMMARY OF INCOME 2001-2011

	Exchequer Grant €	Capital Grant €	Total Grant €	Project Income €	Other Income €	Total Income €	Overall Total €
2011	7,020,000	250,604	7,270,604	2,450,582	107,014	2,557,596	9,828,200
2010	7,213,000	292,846	7,505,846	3,103,885	493,382	3,597,267	11,103,113
2009	7,905,000	1,256,302	9,161,302	4,096,104	611,586	4,707,690	13,868,992
2008	8,044,000	0	8,044,000	4,662,941	723,902	5,386,843	13,430,843
2007	7,732,000	150,000	7,882,000	6,829,359	197,047	7,026,406	14,908,406
2006	6,952,000	0	6,952,000	2,851,452	72,000	2,923,452	9,875,452
2005	6,578,000	0	6,578,000	2,473,148	116,105	2,589,253	9,167,253
2004	6,360,000	0	6,360,000	2,688,666	176,944	2,865,610	9,225,610
2003	5,993,000	0	5,993,000	770,654	192,297	962,951	6,955,951
2002	5,636,000	0	5,636,000	629,726	157,464	787,190	6,423,190
2001	5,384,000	0	5,384,000	224,015	158,488	382,503	5,766,503

Note: The above does not include the adjustment for FRS 17 as required for the Annual Accounts.

APPENDIX 3
SUMMARY OF EXPENDITURE 2001-2011

	Payroll €	Rent Rates Insurance €	Premises Maint. Security & Utilities €	Library and Publications €	Project Costs €	General Expenses €	Other Expenditure €	Depreciation and Tfr. to Capital Reserves €	Total Expenditure €
2011	5,925,681	195,058	358,734	251,377	2,250,109	209,588	317,317	409,994	9,917,858
2010	6,013,544	196,249	428,763	269,126	3,179,998	306,378	690,354	318,863	11,403,275
2009	6,506,271	176,030	396,793	273,757	3,904,099	260,575	656,180	1,520,478	13,694,183
2008	6,385,509	173,425	376,938	298,659	4,611,756	243,020	761,408	250,430	13,101,145
2007	6,127,577	157,471	402,195	267,128	4,160,622	348,306	449,809	2,831,502	14,744,610
2006	5,410,849	113,526	251,817	323,507	2,728,036	226,190	428,051	376,906	9,858,882
2005	5,032,424	120,551	300,491	274,560	2,432,526	197,577	378,207	188,187	8,924,523
2004	4,973,219	126,665	237,298	261,786	2,666,351	187,822	398,094	229,435	9,080,670
2003	4,385,317	183,010	230,167	287,502	738,218	142,400	366,351	348,345	6,681,310
2002	4,021,650	167,266	175,801	231,211	604,761	115,471	382,982	365,766	6,064,908
2001	3,816,022	152,712	177,411	240,803	224,523	134,382	412,939	247,719	5,406,511

APPENDIX 4
STAFFING AS AT 31 MAY 2012

Staff		Celtic Studies	Cosmic Physics	Theoretical Physics	Administration
Exchequer Funded *Schools*					
Senior Professors		3	2	3	
Professors		1	3		
Assistant Professors Dialectologist		2 1	2		
Fellows		1	3	3	
Research Assistants		1			
Experimental Officers			1		
Technicians		1	7		
Secretarial and Tech Support		4	1	2	
Administration					
Registrar					1
Admin. + HR					2
IT					3
Finance					4
Other					10
Total Exchequer	**61**	**14**	**19**	**8**	**20**

Scholars		Celtic Studies	Cosmic Physics	Theoretical Physics	Administration
Total Exchequer	**14**	4	6	4	

Staff		Celtic Studies	Cosmic Physics	Theoretical Physics	Administration
Non – Exchequer Funded					
IRCSET			1	2	
IRCHSS		1			
e-INIS			1		
Others			2		
Total Non Exchequer	**7**	**1**	**4**	**2**	

Scholars		Celtic Studies	Cosmic Physics	Theoretical Physics	Administration
Non – Exchequer Funded					
IRCSET			1		
SFI			13		
Others			2	1	
Total Non Exchequer	**17**		**16**	**1**	

APPENDIX 5 INTERNATIONAL SCHOLARS AND VISITORS TO DIAS 2001-2011

Country	Total
Algeria	3
Armenia	2
Australia	8
Austria	12
Belgium	7
Brazil	2
Canada	19
China	3
Costa Rica	1
Czech Republic	10
Denmark	4
Finland	7
France	63
Georgia	2
Germany	95
Greece	1
Holland	1
Hungary	6
Iceland	1
India	13
Iran	1
Israel	1
Italy	33

Country	Total
Japan	18
South Korea	1
Luxembourg	1
Mexico	11
Netherlands	25
New Zealand	1
Norway	4
Poland	3
Portugal	2
Romania	2
Russia	33
Slovakia	3
South Africa	6
Spain	11
Sweden	17
Switzerland	15
Thailand	1
Turkey	2
UK	139
Ukraine	2
USA	111
Total	**703**

APPENDIX 6 SCHOLARS ACHIEVING NATIONAL AND INTERNATIONAL DISTINCTION

School of Celtic Studies – Scholars achieving national and international distinction	
Name	**Position held subsequently**
Ahlqvist, Anders	Sir Warwick Fairfax Professor of Celtic Studies, University of Sydney
Bachellery, Edouard	Directeur d'Etudes, Ecole Pratique des Hautes Etudes, Paris
Breatnach, Liam	Professor of Early Irish, Trinity College Dublin, Senior Professor DIAS
Breatnach, Pádraig A.	Professor of Classical Irish, University College Dublin, Senior Professor DIAS
Charles-Edwards, Thomas	Professor of Celtic, University of Oxford
Corthals, Johan	Professor of Indo-European, University of Hamburg
Duffy, Sean	Associate Professor of History, Trinity College Dublin
Eska, Joseph	Professor and Department Chair, English Department, Virginia Technical Institute and State University
Gillies, William	Professor of Celtic, University of Edinburgh
Herbert, Máire	Professor of Early and Medieval Irish and Dean of Faculty of Celtic Studies, University College Cork
McCloskey, James	Professor of Linguistics, University of California, Santa Cruz
McCone, Kim	Professor of Old & Middle Irish, NUI, Maynooth
McLeod, Neil	Professor of Law, Murdoch University, Australia
Mac Niocaill, Gearóid	Professor of History, NUI, Galway
Ní Chatháin, Próinséas	Professor of Early and Middle Irish, University College Dublin
Ní Dhonnchadha, Máirín	Professor of Old and Middle Irish, NUI, Galway
Ní Mhaonaigh, Máire	Reader in Celtic, Cambridge University
Ó Cathasaigh, Tomás	Henry L. Shattuck Professor of Irish Studies, Harvard University
Ó Corráin, Donnchadh	Professor of Medieval History, University College Cork
Ó Cróinín, Dáibhí	Associate Professor of Medieval History, NUI Galway
Poppe, Erich	Professor, Department of Comparative Linguistics/Celtic Studies, University of Marburg
Schmidt, Karl Horst	Professor of Indo-European Linguistics, University of Bonn
Simms, Katharine	Senior Lecturer in History, Trinity College Dublin
Tristram, Hildegard L. C.	Professor, Department of English, Albert-Ludwigs-Universität, Freiburg
Watson, Seosamh	Professor of Modern Irish Language and Literature and Dean of Faculty of Celtic Studies, University College Dublin

APPENDIX 6 SCHOLARS ACHIEVING NATIONAL AND INTERNATIONAL DISTINCTION (CONTINUED)

School of Theoretical Physics – Scholars achieving national and international distinction	
Name	**Position held subsequently**
Balazs, Nandor	Professor, Department of Physics, SUNY, Stony Brook
Balog, Janos	Professor, Research Institute of Particle Physics, Budapest
Bass, Ludvik	Professor, Department of Mathematics, University of Queensland
Basu, Debidas	Director, Indian Association for the Cultivation of Science
Bellomo, E.	Professor, Department of Theoretical Physics, University of Genoa
Bertotti, Bruno	Emeritus Professor, Department of Theoretical Physics, University of Pavia
Ciulli, Sorin	Emeritus Professor of Theoretical Physics, University of Montpellier
Cooperstock, Fred	Emeritus Professor of Physics, University of Victoria, British Columbia
Dabroswki, Ludwik	Professor of Theoretical Physics, SISSA, Trieste
DeWitt-Morette, Cécile	Professor, Department of Physics, University of Texas, Austin and Director of Les Houches Summer Institute
Evans, David E.	Professor of Mathematics, University of Wales, Cardiff
Feher, Laszlo	Professor, Department of Mathematics, University of Szeged
Fordy, Allan	Professor of Mathematics, University of Leeds
Gibbons, John	Professor of Mathematics, Imperial College London
Gruber, Bruno	Emeritus Professor, Department of Physics, University of Southern Illinois
Gupta, Suraj	Emeritus Professor, Department of Physics, Wayne State University
Hamilton, James	Director, Nills Bohr Institute, Copenhagen
Harte, Vincent	Professor, Department of Mathematics, University of Queensland
Henneberger, Walter	Professor, Department of Physics, Fordham University
Horvath, Zalan	Head of Institute for Theoretical Physics, Eotvos University, Budapest
Horvathy, Peter	Professor of Mathematics, University of Tours
Israel, F.R.S., Werner	Emeritus Professor of Theoretical Physics, University of Alberta
Kamber, Franz	Emeritus Professor, Department of Mathematics, University of Illinois
Khan, I.	Professor, Department of Maths Physics, University of Khartoum

School of Theoretical Physics – Scholars achieving national and international distinction (continued)	
Klein, Martin	Professor, Department of Physics, Yale University and Member of U.S. National Academy of Sciences
Ma, S. T.	Professor, Department of Maths Physics, University of Sydney
Mast, Cecil	Professor, Department of Physics, University of Notre Dame
McMullan, David	Professor of Theoretical Physics, Plymouth University
McMullin, Ernan	Chairman, Department of Philosophy, University of Notre Dame
Misra, M.	Professor of Mathematics, Gujarat University, India
O'Connell, Neil	Professor of Mathematics, University of Warwick
O'Connell, Robert	Emeritus Professor of Physics, Louisianna State University
Ortiz, Eduardo	Emeritus Professor of Mathematics, Imperial College, London
Papapetrou, Achilles	Professor of Theoretical Physics, Institut Pierre et Marie Curie, Paris
Parravicini, Guido	Professor of Theoretical Physics, University of Milan
Peng, Hwan-Wu	Professor, Academia Sinica, Beijing
Perjes, Zoltan	Professor of Theoretical Physics, Central Research Institute for Physics, Budapest
Pirani, Felix	Emeritus Professor of Mathematics, King's College London
Raggio, Guido	Professor of Mathematics, University of Cordoba
Rasche, Gunther	Professor of Theoretical Physics, University of Zurich
Rawnsley, John	Professor of Mathematics, University of Warwick
Rouhani, Shanin	Professor, Department of Maths Physics, Technical University Teheran
Ruelle, Philippe	Professor of Theoretical Physics, University of Louvain-la-Neuve
Shimodaira, Hajime	Professor of Theoretical Physics, University of Tokyo
Sil, N.C.	Professor, Indian Association for the Cultivation of Science
Solomon, Alexander Isaac	Emeritus Professor of Mathematics, Open University
Strathdee, John Alexander	Vice-Director, ICTP, Trieste
Straumann, Norbert	Professor of Theoretical Physics, University of Zurich

APPENDIX 6 SCHOLARS ACHIEVING NATIONAL AND INTERNATIONAL DISTINCTION (CONTINUED)

School of Theoretical Physics – Scholars achieving national and international distinction (continued)	
Symonds, Neville	Professor of Microbiology, University of Sussex
Takahashi, Yasushi	Emeritus Professor of Theoretical Physics, University of Alberta
Thirring, Walter	Emeritus Professor, Institute for Theoretical Physics, Vienna
Tsutsui, Izumi	Professor, Institute for Nuclear Study, University of Tokyo. Yukawa Prize for Young Japanese Physicists 1996
Van den Berg, Michiel	Professor, Department of Mathematics, University of Bristol
Werner, Reinhard	Professor of Theoretical Physics, University of Osnabrueck
Wilson, Raj	Professor, Department of Physics, University of Texas at San Anton
Wipf, Andreas	Professor of Theoretical Physics, University of Jena
Zorski, Henryk	Professor, Polish Academy of Science

School of Cosmic Physics – Scholars achieving national and international distinction	
Name	**Position held subsequently**
Alexander, Gideon	Professor, School of Physics and Astronomy, Tel Aviv University
Argue, Arnold Noel	Senior Research Scientist, The Observatories, Cambridge
Bean, Chris	Professor, Geophysics, University College Dublin
Corcoran, David	Senior Lecturer, University of Limerick
Duffy, Peter	Professor, University College Dublin
Kazuno, Mitsuko	Professor, Department of Physics, Toho University, Japan
Lowe, Carmel	Director, Geological Survey of Canada
Masson , Frederic	Professor, Geophysics, University of Strasbourg
McCusker, Brian	Professor, Physics Department, University of Sydney, Australia
Messel, Sir Harry	Emeritus Professor and Founding Head of the School of Physics at the University of Sydney, Australia
Millar, Donald	Professor, Physics Department, University of Sydney, Australia
Mond, Michael	Senior Professor, Department of Plasma Physics, Ben-Gurion University, Israel

School of Cosmic Physics – Scholars achieving national and international distinction (continued)	
Page, Edgar	Head of Space Science Division, European Space Agency
Parizot, Etienne	Professor, Paris VII
Rao, Venkat	Professor, Physics Department, Emmanuel College, Boston, Mass., USA
Reid, Robert	Professor, Physics Department, University of Sydney, Australia
Riddihough, Robin	Senior Advisor to Deputy Minister, Natural Resources, Geological Survey of Canada
Ritson, David	Emeritus Professor of Physics, Stanford University, California, USA
Robinson, Keith	Director, Petroleum Affairs Division
Shah, Tara Prasad	Senior Physicist, Rutherford Appleton Laboratory, UK
Wilkinson, Mark	Staff Astronomer, Cambridge University, UK
Wilson, Brian	Chancellor, University of Calgary, Canada

APPENDIX 7 EXTERNAL REVIEW

The quinquennial external review process is an important factor in assisting each School to deliver globally significant contributions in its niche areas of research. These independent reviews, benchmark DIAS research against global standards and provide a rigorous and exacting assessment of quality. The outcomes of the reviews have been extremely positive and confirmed the excellence of the research carried out in DIAS. In 2009 the key conclusions from the external review process were as follows:

> In relation to SCP the review group noted "Over the past five years, its astrophysicists and astronomers have successfully studied a wide variety of high-energy phenomena observed in various parts of the universe, produced significant new observational and computational information on star formation processes and investigated the effects of cosmic radiation on the health of crews in high flying aircraft and astronauts. The School has also become an emerging world leader in electromagnetic geophysics, seismology, marine geophysics and geodynamics".

> The review of SCS concluded that "The School's publications are in constant use in courses in Celtic Studies throughout the world. At a time when Celtic Studies is expanding internationally, the resources now being made available online by the School are immensely valuable. In short, the work of the School is of great importance not only to Ireland but internationally and not narrowly to Celtic Studies but to linguists, historians, medievalists and scholars of other disciplines".

> The review of STP highlighted that "The School plays a very important role in focusing on curiosity-driven research in theoretical and mathematical physics in Ireland, defining and keeping up very high scientific standards and connecting theoretical science in Ireland with the outside world. Its research output is excellent and has considerable impact, nationally and internationally".

The comments of the review groups quoted above highlight the excellence of the research being carried out by each School. This confirms that the State investment is delivering globally significant results and that DIAS is a national asset which enhances Ireland's reputation as a location where world-class research is carried out.

2009 Review Panel Members: School of Celtic Studies

Name	Position
Professor Tomás Ó Cathasaigh (Chair)	Henry L. Shattuck Professor of Irish Studies, Harvard University
Professor James McCloskey	Professor of Linguistics, University of California, Santa Cruz
Professor Catherine McKenna	Margaret Brooks Robinson Professor of Celtic Languages and Literatures, Harvard University
Professor Damian McManus	Professor of Early Irish, Trinity College Dublin
Professor Patrick Sims-Williams	Professor of Celtic Studies, Aberystwyth University

2009 Review Panel Members: School of Theoretical Physics

Name	Position
Professor Jürg Fröhlich (Chair)	Professor of Theoretical Physics, E.T.H. Zurich
Dr Peter Goddard	Director, Institute for Advanced Study, Princeton
Professor David Spearman	Pro-Chancellor TCD and past President of the Royal Irish Academy
Professor Anne Taormina	Mathematical Physicist, Durham University
Professor Peter Higgs	Professor Emeritus, University of Edinburgh

2009 Review Panel Members: School of Cosmic Physics

Name	Position
Dr Thijs de Graauw (Chair)	Director, ALMA Observatory, Chile
Professor Alan Watson	Professor of Physics, School of Physics and Astronomy, University of Leeds
Professor Ed van den Heuvel	Professor of Astronomy, Astronomical Institute Anton Pannekoek, University of Amsterdam
Professor Cecilia Ceccarelli	Professor of Astrophysics, Laboratoire d'Astrophysique de Grenoble
Professor Laust Pedersen	Professor of Solid Earth Physics, Uppsala Universitet
Professor Randy Keller	Professor and Chair of the School of Geology and Geophysics, University of Oklahoma
Professor Peter Mitchell	Professor of Physics, School of Physics, UCD

APPENDIX 8 MEMBERS OF COUNCIL AND GOVERNING BOARDS

Council of the Institute

Name	Position
Dr Vincent Cunnane (Chairman)	Chief Executive Officer, Shannon Development
Ex-Officio Members:	
Dr Hugh Brady	President, University College Dublin
Professor Patrick Prendergast	Provost, Trinity College Dublin
Professor Luke Drury	President, Royal Irish Academy
Members Appointed by the Governing Boards of Constituent Schools:	
Professor Gerard Wrixon School of Cosmic Physics	Immediate past President, University College Cork
Professor Arthur Jaffe School of Theoretical Physics	L.T. Clay Professor of Mathematics and Theoretical Science, Harvard University
Professor Anders Ahlqvist School of Celtic Studies	Sir Warwick Fairfax Professor of Celtic Studies, University of Sydney
Professor Werner Nahm	Director, School of Theoretical Physics
Professor Padraig Breatnach	Director, School of Celtic Studies

School of Celtic Studies Governing Board

Name	Position
Professor Anders Ahlqvist (Chairman)	Sir Warwick Fairfax Professor of Celtic Studies, University of Sydney
Appointed Members of the Governing Board:	
Professor Máire Herbert	Professor and Head of Department, Old and Middle Irish, University College Cork
Professor Ruairí Ó hUiginn	Professor in Modern Irish, Department of Modern Irish, NUI Maynooth
Dr Eilís Ní Dhea	Lecturer in Irish, University of Limerick
Dr Katharine Simms	Senior Lecturer in History, Trinity College Dublin
Dr Nollaig Ó Muraíle	Lecturer, Department of Irish, NUI Galway
Professor Ailbhe Ó Corráin	Professor of Modern Irish, University of Ulster
Dr Máire Ní Mhaonaigh	Reader in Celtic Fellow, St John's College, Cambridge
Professor Jim McCloskey	Professor of Linguistics, University of California, Santa Cruz
Dr Uáitéar Mac Gearailt	Senior Lecturer, DCU/St Patrick's College, Drumcondra
Senior Professors (ex-officio):	
Professor Pádraig Breatnach	
Professor Liam Breatnach	
Professor Fergus Kelly	

School of Theoretical Physics Governing Board

Name	Position
Professor Arthur Jaffe (Chairman)	L.T. Clay Professor of Mathematics and Theoretical Science, Harvard University
Appointed Members of the Governing Board:	
Dr Ann Christine Breslin	Senior Lecturer (Emeritus), College of Engineering, Mathematical & Physical Sciences, UCD
Professor Dr Hermann Nicolai	Director, Max Planck-Institut für. Gravitationsphysik (Albert-Einstein-Institut) Potsdam
Professor Martin W. Grünewald	Professor of Experimental Physics, School of Physics, UCD
Dr Michael Tuite	Senior Lecturer, Department of Applied Mathematics, School of Mathematics, Statistics and Applied Mathematics, NUI, Galway
Professor Sir Peter Knight	Senior Research Investigator, Physics Department, Imperial College London and Principal of the Kavli Royal Society International Centre.
Professor Lene V. Hau	Mallinckrodt Professor of Physics and of Applied Physics, Harvard University
Professor Robbert Dijkgraaf	Director of the Institute for Advanced Study, Princeton
Professor Samson Shatashvili	University Chair of Natural Philosophy, School of Mathematics, TCD
Professor Daphne Gilbert	Head of the Department of Pure and Applied Mathematics (retired), School of Mathematical Sciences, DIT
Professor Jürg Fröhlich	Professor of Theoretical Physics, E.T.H. Zurich
Professor Dr Don Zagier	Director, Max Planck Institute for Mathematics and Professor at the Collège de France, Paris

School of Theoretical Physics Governing Board (continued)

Name	Position
Senior Professors (ex-officio):	
Professor Werner Nahm	
Professor Denjoe O'Connor	
Professor Tony Dorlas	

School of Cosmic Physics Governing Board

Name	Position
Professor Gerard Wrixon (Chairman)	Immediate past President, University College Cork
Appointed Members of the Governing Board:	
Professor Aftab Khan	Emeritus Professor of Geophysics, University of Leicester
Dr Otto Glaser	Industrialist (Telecommunications)
Mr Leo Enright	Journalist & former Chairman of Discover Science and Engineering programme
Professor Ron Perrott	Professor of Software Engineering, Queen's University of Belfast
Professor C. Mary. R. Fowler	Professor of Geophysics and Dean of Science Faculty, Royal Holloway University of London
Professor Sierd Cloetingh	Scientific Director of the Netherlands Research Centre for Integrated Solid Earth Sciences
Professor Laust Pedersen	Professor of Solid Earth Physics, Uppsala Universitet

School of Cosmic Physics Governing Board (continued)

Name	Position
Professor Cecilia Ceccarelli	Professor of Astrophysics, Laboratoire d'Astrophysique de Grenoble
Dr Eucharia Meehan	Head of Research Programmes and Capital Investment, Higher Education Authority and Director of Irish Research Council
Professor Alan Watson	Professor of Physics, School of Physics and Astronomy, University of Leeds
Senior Professors (ex-officio):	
Professor Luke Drury	
Professor Alan Jones	

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